REPORT

ON THE

IMPROVEMENT OF INDIAN AGRICULTURE.

BY

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SECOND EDITION.

With an Appendix containing the Resolutions of the Government of India on the Proceedings of the Agricultural Conferences of 1893 and 1895-96.

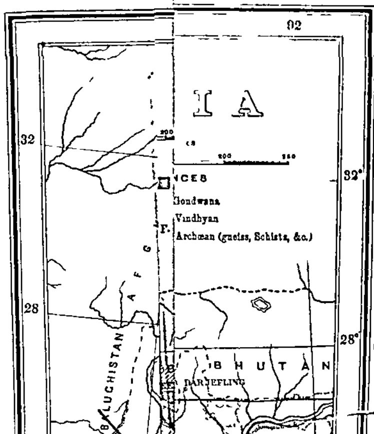
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PREFACE.

WHAT was intended to be a short Report on the Improvement of Indian Agriculture has, owing to the comprehensiveness and importance of the subject, become expanded into a volume of over 400 pages.

I have not attempted any description of the crops or of the methods of agriculture pursued, but have endeavoured to confine myself to matters in which I believe that improvement can be effected.

While the conclusions I have formed are the result of my own personal observation, I am yet very deeply indebted to others for the information I have collected, and, in particular, to the Government of India and its officials for the exceptional advantages I have enjoyed.

I desire to return publicly my sincere and grateful acknowledgments.

KENSINGTON, LONDON, W.,
March 1893.

J. A. V.

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CHAPTER I.

CHAPTER I

HISTORICAL INTRODUCTION.

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THE opening chapter deals briefly with the history of Agricultural Departments in India since their establishment by Lord Mayo in 1871.

The failure and abolition of the first Agricultural Department in 1878, and its reconstruction in 1881 as the outcome of the Report of the Famine Commissioners of 1880, are touched upon, and the steps taken by the Government of India in carrying out the recommendations of the Famine Commission are reviewed It is pointed out that the Government of India, in their Resolution of December 1881, clearly recognised the importance of the systematic prosecution of agricultural *enquiry* which had been so strongly urged by the Famine Commissioners, and that the C ... D

condition of the country

The Land Record system, the importance of which was established by the enquiry of the Finance Commission of 1887, is then summarised The reasons, of which the chief was financial pressure, why the further recommendations of the Famine Commissioners in regard to agricultural improvement were not taken ... epart- ... upon ... ell as the further obligation, imposed on them by the Home Department in 1889, to promote agricultural education It is next pointed out that the Agricultural Department, having, by means of the Famine Code, made provision against the difficulties of famine, and having organised the Land Record system, are now prepared to take up the question of agricultural improvement

In this connection it is stated that the assistance of a first-class Agricultural Chemist has been urged repeatedly since 1882, both by the Government of India and by Agricultural Conferences which have met in India, and that finally Her Majesty's Secretary of State consented in August 1889 to send out an Agricultural Chemist to make enquiries in India itself, and to advise upon the course to be pursued, as also to report upon the possible improvement of Indian Agriculture For this duty, I was, on the recommendation of the late Sir James Caird, selected

The remainder of the chapter is taken up with a summary of my tour, the plan I adopted in pursuing my enquiry, and the expression of my special obligations to those who so largely assisted me in my work

CHAPTER II

CHAPTER II

PRELIMINARY REMARKS ON THE POSSIBILITY OF IMPROVING INDIAN AGRICULTURE

PRELIMINARY REMARKS ON THE POSSIBILITY OF IMPROVING INDIAN AGRICULTURE

In this chapter I give, so far [illegible] marks on the condition of Indian [illegible] its being improved, and the meth[illegible] point out, however, that the diversities met with in India, alike in its physical features, the people themselves, and their varying surroundings, raise great difficulties which altogether prevent one from speaking generally as to the condition of agriculture What is true of one part will not be true of another, and almost no question whatever can be answered in the same way for the whole of India. Thus, the problem of improvement becomes a specially difficult one.

I explain that I do not share the opinions which have been expressed as to Indian Agriculture being, as a whole, primitive and backward, but I believe that in many parts there is little or nothing that can be improved, whilst where agriculture is manifestly [illegible] of facilitie[illegible] bad system [illegible] possible is shown, I think, by the differences of agricultural conditions and practice that exist in different parts of India These differences I proceed to divide into three classes as follows —

(1) Differences *inherent to the people themselves* as cultivators, for instance, "caste" and "race" distinctions

(2) Differences *arising from purely external surroundings*, for instance, climate and soil, varying facilities for water, manure, wood, grazing, etc

(3) Differences *arising directly from want of knowledge*, such as, diversities in agricultural practice.

In treating of the above generally, I express my opinion that improvement of agriculture will consist mainly in the modification of the differences which exist, and that this will proceed in two directions, (1) by the transference of a better indigenous method from one part where it is practised, to another where it is not, (2) by the modification of the differences which result from physical causes affecting agriculture I then discuss how far this work may be effected by the people themselves, as they come to see the necessity of adopting the more profitable methods, and how far by Government, in promoting education, and in taking positive measures such as the provision of water, wood, manure, grazing, etc, where needed As a necessary preliminary to the taking of positive measures, I support strongly in this chapter the opinion of the Famine Commissioners and of the Government of India in 1881, that a "systematic prosecution of agricultural *enquiry*" is absolutely necessary in order to get a real knowledge of

the agricultural needs and condition of each district of the country, and I think that there should be a *permanent agency* for the purpose in each Province, and that in such agency the assistance of an agricultural chemist would be advantageous

I conclude the chapter by recommending (1) the spread of General and Agricultural Education, (2) the establishment of an organised system of Agricultural Enquiry, (3) the active prosecution and encouragement of positive measures, such as the supply of water, wood, etc, which have already been found to be beneficial RECOMMENDATIONS.

CHAPTER III.

CHAPTER III.

CULTIVATING CLASSES

CULTIVATING CLASSES

It is pointed out that certain "castes" and "races" of the people of India show more agricultural ability than others, and that the differences between them as cultivators are in great measure to be referred to the caste or race distinctions existing between them It is very certain that if the prejudices attaching to caste and race could be broken down, considerable improvement in agriculture would result Instances are next given which show indications of a change slowly going on. Thus, the prejudices against the cultivation of indigo and of the potato have, to a great extent, disappeared, also the cases of Nagpur, Poona and Amritsar are mentioned as showing that the prejudice against the use of night soil as manure for crops is giving way. Improvement in coffee cultivation and in the manufacture of indigo, as the outcome of the example of English planters, is also distinctly traceable The people, it is pointed out, will lose those caste prejudices which retard improvement in agriculture, partly through the spontaneous adoption by them of the more profitable practices, and partly from the force of circumstances which make living harder and oblige more attention to be paid to cultivation In the weakening of caste prejudice Education is a most important factor, and Government by spreading it will help to break down the caste distinctions which prevent progress in agriculture

I therefore advocate the spread of General and Agricultural Education. RECOMMENDATION

CHAPTER IV.

CHAPTER IV.

CLIMATE.

CLIMATE

With the aid of the "Rainfall Map" included in the Report, the great variations of climatic conditions throughout India are illustrated, and their bearing is shown upon the crops grown, the agricultural systems pursued, the cattle, and even the people themselves The close connection of famine with the rainfall is also set forth. It is pointed out that while it is to only a limited extent that climatic differences can be modified, yet that something can be done by increasing the means of irrigation in dry tracts, and by the creation of "reserves" of wood and fodder in districts where these are scarce. The influence of vegetation, and especially of trees, in improving climate is discussed, the real value consisting in the lowering of temperature, the production of a more gentle rainfall, the increase in the number of rainy days, the holding up of the soil, the obtaining of a cooler earth surface, and the retention of moisture by the soil.

It is maintained that such work must fall to the lot of Government, and that the people can be expected to do but little to aid it Encouragement is, however, given to tree-planting by individuals, and this should be prosecuted more vigorously. It is further insisted that in order to get definite knowledge as to where provision of irrigation and "reserves" of wood and fodder can be made, careful enquiry must be set on foot by Agricultural Departments

RECOMMENDATIONS

I recommend, accordingly, (1) the extension of irrigation to dry tracts, (2) the creation of "reserves" of wood and fodder (called "Fuel and Fodder Reserves"), (3) the planting of trees along canal banks and railway lines; (4) the further encouragement of Arboriculture, (5) organised enquiry by Agricultural Departments with the view of finding out where the foregoing measures can be adopted

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CHAPTER V.

CHAPTER V.

SOIL.

SOIL.

The principal geological types of soil which occur in India are illustrated by the help of the "Geological Map" accompanying the Report, and the presence or absence of particular kinds of soil are indicated The neglect, in the past, of any regular scientific study of Indian soils is referred to, and the important question is next dealt with—whether or not the soil of India is becoming exhausted under the present systems of cultivation. It is admitted that there is want of positive evidence in support of exhaustion, but instances are given from Settlement Reports and from the Famine Commission's Report, of a process of deterioration

going on, and it is argu [illegible] of grain, oil seeds, and [illegible] for fuel, there must [illegible] wheat-yield of India is [illegible], and Sir James Caird's estimate of the crop-increase needed to [illegible] -uction is drawn [illegible] but an *increased* [illegible] his can only be [illegible] the manure supply. The soils of India [illegible] constituents which [illegible]. It is shown how [illegible] t organic matter (*humus*) and nitrogen are generally deficient in Indian soils, and that lime, potash and phosphoric acid are, as a rule, present in sufficiency. Several chemical questions of great importance are dealt with, such as the supply to plant life of nitrogen from atmospheric sources, the amount of nitrogen contained in the rainfall of India, the nature, occurrence and possible removal of saline deposits in soil, etc The reclamation of land, whether it be ravine land, land infested with weeds, or land rendered sterile by the presence of salts (*usar* land), is dealt with, and instances are given of the various experiments which have been tried in [illegible] t is shown that the [illegible] various agricultural [illegible] necessary, and it is urged that future investigation should be pursued with its assistance

In conclusion, it is pointed out that the work of soil improvement must devolve mainly upon Government, as in very few cases will the people have the means to take such measures in hand

I recommend in connection with the improvement of the soil, (1) the increase of the supply of water to dry tracts; (2) the increase of the manure supply; (3) the setting on foot of enquiry to ascertain where such improvements are needed; (4) the continuation of experimental research aided by chemical science. RECOMMENDATIONS

CHAPTER VI

CHAPTER VI.

WATER.

WATER.

It is indicated, at the outset, that while water in one form or another is indispensable in Indian agriculture, the amount and the method of supply will vary very greatly in different parts of India. In some parts rainfall is sufficient, in others artificial irrigation will be a necessity, in others, again, it may be a useful supplement. The nature of "protected" and "precarious" tracts is pointed out. The main types of water supply are summarised and then examined *in extenso*. Special points are noted, such as the benefits and the evils attending the introduction of canals, the comparison (where it is possible to make it) between cultivation by canal irrigation and by well irrigation, the differences in chemical composition between canal water and well water, etc. Embanking and drainage of land are spoken of, and instances are given of parts which stand in need of further irrigation. The great work done by Government in extending canals is favourably reviewed, and direction is turned to the necessity of Government undertaking all works of a major character, while minor ones may be carried out by the people. The possibility of Government constructing wells on a large scale is discussed, and improvements are suggested in the management of canal watercourses and tanks, and in the repair of the latter. The chapter goes on to treat fully of the system of advances known as *taccavi*, principally for purposes of well digging, and it is shown how greatly this is capable of further development, and of being made more popular and useful. It is maintained that the Agricultural Department should pay particular attention to this subject, and that a certain share of the administration should be vested in the Department. Suggestions are made as to improvements in the working of the system. Lastly, the necessity of a thorough "agricultural analysis" of each district of the country is insisted on with the view of ascertaining the local requirements in the way of water supply.

RECOMMENDATIONS.

I recommend (1) the further extension of canals and other means of irrigation to tracts where they are required, (2) the more energetic working and popularising of the system of *taccavi* advances for well digging and similar purposes, (3) the giving of a share in the administration of *taccavi* advances to Agricultural Departments, (4) the institution by Agricultural Departments of organised enquiry to ascertain the irrigation requirements of each district.

CHAPTER VII.

CHAPTER VII. — Manure.

MANURE.

The importance of manure in Indian agricultural systems is illustrated by extracts from various Reports, and the interdependence of water and manure is shown in the existence of the finest cultivation where both water and manure are available. Instances are given to show that the cultivator is not ignorant of the value of manure, but will, for certain crops, spend considerable sums of money upon it. The different sources of manurial supply are then examined, the ordinary cattle-manure being the most important, and, speaking generally, the only one available. Its composition is set out in analytical tables, and a comparison is instituted between it and ordinary farmyard manure, as met with in England, the result being to show that the value of Indian cattle-manure is often underrated, and that when it is burnt (as is so often the case) very serious loss is incurred. As the outcome of an enquiry in which I specially interested myself, I state the conclusion I came to, *viz.*, that the best cultivators do not burn cattle-manure for fuel except from necessity, that is, because they have nothing else to burn as fuel. The connection between the supply of firewood and that of manure is hence a very close one. Other [illegible] with in succes- [illegible] green-manuring, [illegible] bones, etc., and [illegible] are given in the Appendix. Special questions, such as the system of seed-bed cultivation known as *ráb*, the use and export of bones, and the likelihood of artifical manures being used in India, are treated in detail. Attention is then drawn to two points in which the cultivator does not take full advantage of the facilities he possesses: (1) the non-utilization by him of night-soil for agricultural purposes; (2) the imperfect conservation of cattle-manure and the loss of the urine. In this connection instances are given of the highly beneficial results that have attended the use of night-soil, and analyses are given showing the value of cattle urine and [illegible] of litter. [illegible] are touched [illegible] references [illegible] the aid of [illegible] tained that [illegible] ts, and that the supply of manure must go hand in hand with that of water, and must, like the latter, be taken up by Government, otherwise the soil will n[illegible] people [illegible] available [illegible] vide supp[illegible] the cattle-manure need not be burnt, but may be set free for use on the land, and the fertility of the latter be thereby kept up.

CHAPTER VI

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WATER

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annual licenses for the removal of wood, etc., for agricultural uses These views are supported by the [illegible] authorities, and more especially by a recent [illegible] of the Madras Government upon the subject. Cases [illegible] where such "reserves" have been created, and have [illegible] much good It is maintained that the [illegible] must not depend alone upon Forests' considerations, but [illegible] be considered from the point of view of the needs of the [illegible] and the demands of the principal industry of the country, [illegible] agriculture. Extension of the establishment of plantations along canal banks and railway lines is also urged, and the [illegible] encouragement of arboriculture. Lastly, the opinion is expressed that a proportion of the yearly revenue obtained by the Forest Department should be expended in the extension of the work of the Department in an agricultural direction.

I recommend (1) the creation of "reserves" of wood, fuel, [illegible] etc, for agricultural purposes ("Fuel and Fodder Reserves"), (2) the increase of plantations along canal banks and railway lines, (3) the further encouragement of arboriculture, (4) the prosecution of agricultural enquiry for ascertaining the needs of the different cultivating districts in the matter of wood supply, (5) the setting aside yearly of a portion of the revenue derived by the Forest Department, and its employment in the extension of "reserves" to meet agricultural wants.

CHAPTER IX

CHAPTER IX.

GRASS.

Grass.

THE different kinds of grazing areas available for the use of the cattle belonging to cultivators are referred to and attention is drawn [illegible] areas amid the forests [illegible] provision of grazing [illegible] and one which will m[illegible] drought it may be [illegible] the cattle of the country alive Nevertheless, it is not regarded as an absolute necessity in ordinary times, and, therefore, should only be carried on under such restrictions as would cause it not to interfere with the other ends which a forest or "reserve" should serve These various restrictions and the necessity for their imposition are then considered. The question of the utilisation of "village wastes" is next gone into, also the provision of grazing along canal banks and in other plantations The best way of utilising the grass in forests and "reserves," and the possibility of grass-growing and the supply of pasturage becoming a part of the cultivator's system on his own holding are discussed. In the second part of the chapter the system of Grass Farms and the utilisation of uncultivated grass

lands (*rukhs*) belonging to Government are explained, and, while their benefits are recognised and their extension urged, suggestions are also made for their improvement. The methods of hay-making and silage-making as conducted at Government Grass and Experimental Farms are examined, also the relative costs compared with the cost in England The prospects of the development of silage-making in India are treated of and the desirability is urged of making further enquiries at Experimental Farms. Lastly, a change is advocated in the Commissariat Department, whereby the services of men of experience and ability may be retained in the management of Grass Farms, and the formation of a special Forage Branch of the Commissariat is suggested

RECOMMENDATIONS

I recommend (1) the creation of more "Fuel and Fodder Reserves" to supply grass and grazing, (2) the extension of the system of Grass Farms, and their management by a special Forage Branch of the Commissariat, (3) the carrying out of enquiry at Government Experimental Farms on the making of sillage.

CHAPTER X

CHAPTER X

FODDER CROPS AND HEDGES

FODDER-CROPS AND HEDGES

The advantages of growing fodder-crops are set forth and exemplified in the better condition of the cattle in many parts where the system is practised The principal crops used as fodder-crops are mentioned, and, in particular, the utilisation of prickly pear. The ec [illegible] crops is also shown [illegible] the relative values of [illegible] investigation calls for the association of an agricultural chemist. The useful ends served by hedges round fields are explained, and the materials generally used for fencing are named.

RECOMMENDATIONS

I recommend (1) the extension, wherever practicable, of the systems of growing fodder crops and of enclosing fields by hedges, (2) the employment of an agricultural chemist in investigating, among other matters, the relative values of different fodders

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CHAPTER XI

CHAPTER XI

LIVE STOCK AND DAIRYING

LIVE STOCK AND DAIRYING

It is indicated at the opening of this chapter that, since the differences between the cattle of different districts are largely due to conditions of climate, improvement of cattle is only possible within limits. After speaking of their food and the excellence of the cattle in certain districts, it is shown that, as a rule little or no attention is paid to their breeding and selection The Hindu system of breeding from Brahmani bulls is referred to, and the harm is pointed out which is likely to follow from a recent legal decision given in the North-West Provinces as to ownership in [illegible] might well be made centres for locating stud bulls for the improvement of the cattle of the district Accounts are next given of the Hissar and Bhadgaon Cattle Farms, and mention is made of the influence which they, and notably the former, have exercised on the cattle of the country The evils attending frequent changes in the superintendence of Government Cattle Farms are pointed out, as they were in the case of Grass Farms (Chapter IX) Mention is made of the use of buffaloes as plough cattle, and of the giving of advances (*taccavi*) for purchase of cattle

In the second section of the chapter dairying is the main subject, and the special features of the yield and quality of milk from cows and buffaloes are treated of The efforts made to extend dairy farming in India are detailed in connection with the visit of Mr Howman, and the subsequent steps taken by Mr Ozanne in Poona and Bombay The unsatisfactory conditions of the milk supply to towns and to troops, as well as to Government institutions, are referred to, and the establishment of Dairy Farms is advocated wherever troops are quartered or large institutions are situated It is pointed out that there is considerable work for an agricultural chemist to do in the investigation of points connected with dairy farming

A brief reference is made to the operations of the Horse-breeding Department, and to attempts made to improve sheep and goats

The last part of the chapter is taken up with the consideration of Cattle Diseases, the ravages which they cause, and the steps which have been here and there taken to cope with epidemics Special mention is made of the establishment of an Imperial Bacteriological Laboratory at Poona

I recommend (1) the continuance and extension of Cattle Farms, and the distribution from them of stud bulls to villages, (2) the making Experimental Farms and Court of Wards' Estates centres for the location of stud bulls, (3) the establishment of Dairy

RECOMMENDATIONS

Farms for the supply of milk to troops and Government institutions, (4) the appointment of an Agricultural Chemist to investigate matters connected with dairy farming, (5) the prosecution of enquiry into cattle diseases and the means of preventing epidemics.

CHAPTER XII

CHAPTER XII.

IMPLEMENTS.

IMPLEMENTS.

The possibility of effecting improvement in the implements of the cultivators is reviewed, and the opinion is expressed that there is but little scope for improvement, and that any advance must be the outcome of a study of native requirements. The success of the Beheea sugar-mill is instanced as a case in point The question of the use of the native wooden plough, as against that of the iron one, is fully gone into, the several objections to iron ploughs being discussed, and the circumstances under which they might be usefully employed The chapter then deals with the introduction and possible extension of the iron sugar-mill, the shallow evaporating-pan, and other devices for improving the out-turn of sugar. The possible use of introduced threshing machines, winnowers, chaff-cutters, pumps, and other implements is considered, and the need of more exhaustive trials of implements at Experimental Farms is urged. It is added that in these trials skilled experts such as engineers, chemists, etc., should be associated, according as the enquiry calls for it, and that Experimental Farms should be centres for distributing implements the merits of which have been satisfactorily proved.

RECOMMENDATIONS. I recommend (1) the exhaustive trial of new implements at Government Experimental Farms, (2) the association of "experts" in such enquiries, (3) the distribution of approved implements from Experimental Farms

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CHAPTER XIII.

CHAPTER XIII

CROPS AND CULTIVATION.

Crops and Cultivation.

In this chapter no attempt is made to describe the kinds of crops grown, or the methods of cultivation employed, but points only are discussed in which it seems possible to effect improvement. The general excellence of the cultivation is indicated, and the changes, more especially in wheat-growing, which have been brought about by an export trade, are mentioned. Fallowing and rotation are next taken, and instances are given to show that the native cultivator is not ignorant of either practice. The system of "mixed cropping" is also explained, but it is pointed out that little is known or practised in regard to selection or change of seed, although some Government Experimental Farms have already done good work in growing and distributing pure and selected seed. It is then shown that improvements can be effected by the introduction of new crops, and of new varieties of existing crops, as also in the extended cultivation of certain profitable crops, such as wheat and sugar-cane. It is further demonstrated that by the transference of method from one part to another, improvements in cultivation may be carried out, this is exemplified in the case of sugar-cane, and even in that of a crop so widely cultivated as rice. Reference is made, in conclusion, to the need that exists for getting more knowledge as to the diseases and injuries to which crops are liable, and the best means of preventing them.

Recommendations.

I recommend (1) the continuation of experimental enquiry at Government Farms, in reference to new crops and methods of cultivation, (2) the growing of good seed at Government Farms, and its distribution from them, (3) the study of the diseases and injuries of crops, (4) agricultural enquiry into existing modes of cultivation.

CHAPTER XIV

CHAPTER XIV

AGRICULTURAL INDUSTRIES AND EXPORTS.

AGRICULTURAL INDUSTRIES AND EXPORTS.

THIS chapter deals with certain special crops which undergo a process of manufacture in the country before being sent out of it, or with which particular considerations regarding export are bound up Such crops are sugar-cane, cotton, indigo, tea, coffee, tobacco, flax, jute, silk, wheat, and linseed. These crops are successively treated in view of the improvements which it is possible to effect either in their cultivation, their manufacture, or in the export trade It is first shown that the yield of sugar from sugar cane depends upon points in the cultivation, in the expression of the juice and in its refining, none of which are fully understood Next, the deterioration of Indian cotton is alluded to, and a brief account is given of the efforts that have been made to improve its quality Indigo is treated at some length, and the general want of knowledge both as to its cultivation and the manufacture of the dye, is commented on Reference is made to the need of chemical investigation into problems affecting the manufacture, and to the unsatisfactory conditions which often attend the cultivation Similarly, chemical problems in the manufacture of tea are pointed out The cultivation of coffee is next taken, then that of tobacco, and the native method of curing tobacco is described. After a brief mention of flax and jute, allusion is made to the efforts, so far unsuccessful, to eradicate the disease in silkworms known as *pebrine* The important matter of the cleaning of wheat is dealt with at length, and by the help of analyses which I made of samples taken off the cultivators' own threshing floors, or from stores in their houses, it is shown that the fault attributed to Indian wheat, that it is "dirty," does not rest with the cultivator, but is that of the trade, and more particularly the London Corn Trade, who do not want "clean" wheat The efforts made to improve the trade in this respect, and their failure, are described The applicability of the "elevator" system to India is also discussed Lastly, the conditions of the linseed trade are explained, and are illustrated by analyses of a number of samples of seed collected for me in the Central Provinces

RECOMMENDATIONS.

I recommend (1) agricultural enquiry to ascertain the best methods of cultivation and manufacture of crops such as sugar-cane, indigo, tea, coffee, tobacco, etc, (2) the employment of chemical science in the investigation of problems affecting these industries, and more especially that of an agricultural chemist in connection with the sugar industry, (3) the making it a penal offence to adulterate wheat, or to trade in adulterated wheat.

CHAPTER XV.

CHAPTER XV

ECONOMICAL AND POLITICAL CONDITIONS

ECONOMICAL AND POLITICAL CONDITIONS.

By the insertion of this chapter I wish to recognize the existence of a number of conditions of an economical or political nature which have an important bearing upon the improvement of agriculture, but into the details of which I do not enter Under this head I mention pressure of population, relative ease or difficulty of living by agriculture, varying systems of land tenure, smallness of holdings, paucity of capital, indebtedness of the cultivating classes, export trade, extension of railways, etc My reasons for not discussing these several points are given, the only ones mentioned at any length being the smallness of holdings, the indebtedness of cultivators and the lack of enterprise sometimes found among the people, more especially under easy circumstances of living.

CHAPTER XVI

CHAPTER

PRACTICAL ENQUIRY.

PRACTICAL ENQUIRY

After having sketched out in the previous chapters the principal ways in which I think that improvement of agriculture may be effected, I proceed to consider in those that follow, the agency by which the improvements are to be carried out. A brief review of the recommendations already given points to the conclusion that the main advance will be made by a practical enquiry into native agriculture, with a view to ascertaining (1) the requirements of each district in respect of water, wood, manure, and other facilities, (2) the best native methods of cultivation, in order to transfer them to other districts where they are not practised. A number of opinions in support of this view are quoted, and it is then pointed out that, up to the present, enquiry has been limited to the collection of Land Revenue statistics, and that there has been no organisation for enquiry into agricultural methods with a view to agricultural improvement A large field for enquiry is then sketched out, and the necessity of an agency of an expert nature is urged The opinions of the Famine Commissioners, the Government of India and Provincial Governments, on this point are quoted The existing agency is reviewed, and more particularly the position occupied by the Director of the Department of Land Records and Agriculture in a Province. The lack of technical knowledge in the Department is brought out, and it is suggested that this want could best be supplied by associating with the Director of the Department in any Province a certain number of agricultural experts to be engaged on purely agricultural work. It is then discussed whether these experts should be Europeans or

Natives, and the conclusion is come to that, on the whole, the selection of Natives trained in India would be best, provision being made for the giving of a high class agricultural education in the country itself.

RECOMMENDATIONS

I recommend (1) the organisation of enquiry into agricultural conditions and practices, (2) the association with the Director of an Agricultural Department of one or more assistants who are experts in agriculture, (3) the selection of these assistants from Natives of India trained in the country itself; (4) the provision of a high class agricultural education in India

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CHAPTER XVII — SCIENTIFIC ENQUIRY

CHAPTER XVII

SCIENTIFIC ENQUIRY.

THE close connection of science with practice in any scheme of agricultural improvement is at the outset, put forward and the necessity is shown that practical enquiry should be scientific in its methods The relation of chemistry to agriculture is then pointed out, and reference is made to the expressed opinions and renewed applications of the Government of India on the desirability of having an Agricultural Chemist for India The scope of work for an agricultural chemist is then sketched out, and the principal duties of the office are defined as being the acting as "referee" or adviser to Government in chemico agricultural matters, and the direction and maintenance of the continuity of enquiry Among other duties are those of assisting in the development of agricultural education and the preparation of suitable text-books The necessary qualifications to be possessed by the holder of such an appointment, and the conditions essential to his successful tenure of it, are defined The existence of a suitable laboratory, and the co operation of an assistant chemist (to take actual charge of the laboratory and to give instruction in agricultural chemistry) are regarded as essential The relations, respective duties and salaries of the two officers proposed are discussed, and it is recommended that neither of them be allowed to undertake private work for separate remuneration. It is urged that not only an agricultural chemist, but also other scientific men, such as a botanist, an entomologist, and an agricultural engineer, should be associated with the Agricultural Department for the purpose of conducting enquiry and research The chapter closes by dealing generally with the position of scientific men in India, the encouragement of scientific research, and, in particular, the appointment of Chemical Examiners

RECOMMENDATIONS

I recommend (1) the appointment of an agricultural chemist as adviser to Government in chemico agricultural matters, and for the direction of experimental enquiry, (2) the appointment of an assistant chemist, (3) the attachment to the Agricultural Department of other scientific officers, such as a botanist, an entomologist, and an agricultural engineer

CHAPTER XVIII.

CHAPTER XVIII.

EXPERIMENTAL FARMS

EXPERIMENTAL FARMS

THE causes that have led in India, as well as in other countries, to the establishment of Experimental Farms as separate institutions are first described The past work of such Farms in India is reviewed, and the expenditure upon them is regarded as not having been excessive, and their continuance is advocated The chapter then proceeds to deal at length with the work which ought to be done at Experimental Farms, and to lay down the lines for the successful carrying out of experimental enquiry The various conditions, such as suitability of soil, size of farm, situation, supervision, plan of experiment, recording of results, etc, are discussed, and are illustrated by examples drawn from existing Experimental Farms both in India and in England It is then maintained that in the case of such Farms the financial test ought not to be the one that determines success The employment of Experimental Farms as centres for seed distribution, the location of stud bulls, and, at times, for cattle-breeding, is recommended The establishment of another class of Farms, *viz*, Demonstration Farms, to show the result of what has experi- ... mention is made of ... experiment is more ... chapter is occupied with a review of the work in progress at each of the Experimental Farms which I visited during my tour, my general comments on each Farm being given at the same time

RECOMMENDATIONS

I recommend (1) the continuance of agricultural enquiry at Experimental Farms, (2) the distribution of seed and the location of stud bulls at Experimental Farms, (3) the establishment of Demonstration Farms

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CHAPTER XIX.

CHAPTER XIX.

AGRICULTURAL EDUCATION.

AGRICULTURAL EDUCATION.

THE influence which general education first, and then, more specially, agricultural education, exert upon the improvement of agriculture is, at the opening, explained. It is then shown that the tendency of education in the past has been too much in a literary, and not sufficiently in an agricultural, direction The suggestions now given are with the intention of remedying the past defect, and of directing attention to, rather than diverting it from, the cultivation of the land. The intention is, in brief, to give a more agricultural turn to education The different grades of educational institutions, from Universities and Colleges down to Primary Schools, are then taken in order, and the line of agri-

Natives, and the conclusion is come to that, on the whole, the selection of Natives trained in India would be best, provision being made for the giving of a high class agricultural education in the country itself.

RECOMMENDATIONS

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CHAPTER XVII.

Scientific Enquiry

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principal duties [illegible]
as "referee" or [illegible]
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weight to proficiency in natural science It is then suggested that junior Civilians, or at least a proportion of them, should, on arrival in India, be drafted into Provincial Departments of Land Records and Agriculture, there to learn something about the country, the people, the crops, and the agricultural conditions generally, and that at their departmental examinations they should be required to show an acquaintance with these subjects. It is held that Directors of Agriculture should be chosen from the men who have shown a liking for natural science, and who have distinguished themselves subsequently by their knowledge of agricultural matters The position of the Director of Agriculture is reviewed, and it is urged that it should be invested with some administrative power, and that the Director should form a part of the Revenue Administration The giving to the Agricultural Department of a share in the administration of Government advances (*taccavi*) for well digging is again advocated The necessity that Directors of Agriculture should tour in their districts is insisted upon, and is made applicable in a special way to the Secretary of the Imperial Department of Agriculture The useful purposes which occasional Conferences on agricultural questions can serve are also exemplified The classification of the work of Agricultural Departments is then referred to, and the main heads are briefly noted Among them the importance of "analysis of districts" and the desirability of making a digest of the Land Records are put forward Agricultural Shows are treated at some length, and suggestions are made for their improvement, as also for the better conduct of trials of implements.

In conclusion, the future policy of Agricultural Departments is discussed, and the two great needs—a competent organization, and the expenditure of more money upon agricultural improvement—are put prominently forward Lastly, uniformity of purpose and continuity of policy in the work of Imperial and Provincial Agricultural Departments are strongly urged.

RECOMMENDATIONS

I recommend (1) the giving of more weight to natural science in the open competitive and final examinations for the Civil Service, (2) the drafting of a certain proportion of junior Civilians into the Department of Land Records and Agriculture on their arrival in India, (3) the selection of Agricultural Directors from those who have distinguished themselves in natural science, and subsequently by their agricultural knowledge, (4) the giving of some administrative powers to Agricultural Directors, and, especially, that a share of the administration of Government advances (*taccavi*) be entrusted to Agricultural Departments, (5) the granting of more money to be expended by Agricultural Departments in the work of agricultural improvement.

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(*N B*—The references are to Paragraphs of the Report)

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CHAPTER XX.

AGRICULTURAL DEPARTMENTS.

REPORT ON THE IMPROVEMENT OF INDIAN AGRICULTURE.

CHAPTER I.

HISTORICAL INTRODUCTION

HISTORICAL INTRODUCTION

Early history of Agricultural Departments

THE impro . . . . . is a subject which in recent yea[rs] . . . prominently before the notice of . . . the Home Government It was in 1866, on the conclusion of the work of the Bengal and Orissa Famine Commission, that the policy of having a special Department to watch over the interests of agriculture was first mooted Lord Lawrence, however, thought the step premature In 1870 Lord Mayo again took up the matter, chiefly in relation to the improvement of the supply of cotton from India, and in 1871 the first Agricultural Department was created In Lord Mayo's opinion the work of the new Department was, "to take cognisance of all matters affecting the practical improvement and development of the agricultural resources of the country." Sir Richard Temple further pointed out that the success of a Central Department depended on the support given to it by similar Provincial Departments, the existence of which, under Local Governments, was implied The only Provincial Government, however, which rendered any assistance was that of the North-West Provinces, where, in 1875, under Sir John Strachey, then the Lieutenant-Governor, the appointment of a Director of Agriculture and Commerce, to be at the head of a Department for collecting and arranging statistics of trade and agriculture, was sanctioned for a period of five years Sir John Strachey also advocated the utilisation of Court of Wards' Estates for purposes of investigation, and the employment of them as "Model Farms," and for finding out the real condition of the cultivating classes

Lord Mayo's views 1870.

First Agricultural Department, 1871

Sir John Strachey and Provincial Department of North West Provinces 1875

Failure of Agricultural Department.

2 As regards the Central Department, "though" (to quote the words of the Government of India's Resolution of December 1881) "under Lord Mayo's administration a "Department of Revenue, Agriculture, and Commerce was "created . . . . the actual form departed widely from "Lord Mayo's conception of its proper condition Burdened "with multiform duties the new Department had neither the "*leisure nor the power to take up either directly or efficiently* "the many problems which affect the agriculture and rural "economy of the Empire" On its creation the new Department had handed over to it a number of miscellaneous subjects [w]ith which the three great divisions of the Administration,

The causes

the Financial, Judicial, and Political, did not care to deal. So it came about that, with no definite programme of its own, and amid the varied subjects transferred to it, the new Department lost sight of Agricultural Reform. It was not Lord Mayo's intention that this should be so, but it was mainly from lack of provincial co-operation that his efforts were rendered futile, and in 1878 the Department was re-absorbed in the Home Department. The Secretary of State, nevertheless expressed in a despatch the hope that this step would not interfere with Agricultural Improvement.

Abolition of Department, 1878.

Famine Commission's recommendations 1880.

3. In 1880 the Famine Commissioners in their Report gave very strong recommendations as to the necessity of establishing Agricultural Departments under a Director in each Province. The duties were classed under three heads —

(1) Agricultural Enquiry—the collection of agricultural information to keep the authorities informed of the approach of famine.

(2) Agricultural Improvement—with a view to the prevention of famine in future.

(3) Famine Relief—to take charge of operations in the campaign against actual famine.

Imperial Department of Agriculture reconstituted 1881.

The Secretary of State himself added to the pressure brought to bear by the Famine Commissioners on the Government of India, and, as the outcome, an Imperial Department of Agriculture was formed in 1881 by again separating the Revenue and Agricultural Department from the Home Department. The several Local Governments agreed to this, and, accordingly, action was taken, and measures were commenced in 1882 for the formation of Provincial Departments of Agriculture.

Provincial Departments.

Action taken by Government of India in carrying out recommendations of Famine Commission.

4. It was, perhaps, on the first of the three heads named above that the Famine Commissioners laid most stress, and the Government of India, in accepting the obligations laid upon them, went still further, and, seeing that no special Department could take (as the Famine Commission had contemplated) the administration of famine relief out of the hands of local officials, turned primarily to the organisation of the Land Record system and the simplification of settlement operations. Improvements were made in the village establishments which had been created under the Land Record system for compiling annually and collating the agricultural facts and statistics of every village in each Province; the Provincial Departments were made Departments of Land Records and Agriculture, and to them the maintenance of the above organisation was entrusted; also on them was put the duty of examining the Land Records and Village Maps, and from these and by means of local enquiry there was to be made an "agricultural analysis," which should indicate, not only the circumstances and conditions of each tract, but also the *requirements* of each, whether for protection against famine, or for the improvement of the agricultural system.

Land Record system.

Government of India's Resolution December 1881

In the words of the Government of India's Resolution of 1881, "the Famine Commissioners have with great distinctness "intimated that, apart from any special organisation which "may be required to meet the exigencies of famine, or to "enter into any new field of agricultural experiments, a "permanent agency should be closely associated with the "existing authorities in each Province for the systematic "prosecution of agricultural *enquiry* The importance of "this view, which directs attention to those duties of the "Agricultural Department which must precede any attempt "at agricultural *improvement*, has hitherto been far too "greatly overlooked" The Resolution further quotes the words of the Famine Commissioners, "the success of an "Agricultural Department would mainly depend on the "completeness and accuracy with which agricultural and "economic facts are collected in each village, and compiled "in each subdivision and district throughout the country," and it adds, "the Department would thus naturally acquire "that very knowledge which it has hitherto been the main "effort of a Settlement staff to attain Without doubt, too, a "permanent Department of this kind would in course of time "become more competent to deal with questions of Settlement, "demanding, as they do, an intimate acquaintance with "agricultural conditions, than any temporary Department "forced to gain a hurried experience at great cost to the "country during the actual process of assessment" It was distinctly on the understanding that "Land Revenue Organi-"sation" was to form the first duty of the new Imperial Department that Mr (now Sir Edward) Buck accepted office in August 1881 as its Secretary, in the belief that this work, though not so directly agricultural in character, would lay the foundation of all knowledge of the [illegible] which no attempt [illegible] sense could proceed. [illegible] Provincial Departn[illegible] "Land Revenue Organisation" was then proceeded with, and, when in June 1886 the Secretary of State asked for an enquiry into the expenditure of the new Departments, both Imperial and Provincial, it was found possible to prove satisfactorily to the Finance Commission of 1887 that, on purely financial grounds, and quite apart from any indirect benefit that might have accrued to agriculture, their establishment had been amply justified, and had resulted in the addition of a considerable increase of revenue to the State Thus the importance of the Land Record system was confirmed, but a time of financial pressure having meanwhile set in, both the Revenue and Agricultural Department and the Finance Department shrank from giving anything like wide effect to the bolder recommendations of the Famine Commissioners which involved expenditure on direct agricultural improvement, although they were pressed by the Secretary of State to "institute measures for Agricultural Research in India "and the promotion of agricultural knowledg[illegible] "Service."

Enquiry of Finance Commission, 1887

Importance of Land Record system established

Application for Agricultural Chemist.

5. On one point, however, distinct representations had gone home to the Secretary of State, *viz*, the necessity of having a scientific ground-work as the basis of all attempts at agricultural improvement, and Chemistry being that science which bears, perhaps, most directly on Agriculture, the Secretary of State was asked as far back as 1882 to sanction the appointment of an Agricultural Chemist to act with the Department. It was pointed out, among other things, that there were large tracts of land, especially in the North-West Provinces, which were unculturable on account [illegible]
science mig [illegible]
further inter [illegible]
purposes. [illegible]
1884, 1886, [illegible]
Conference of that year.

Imperial Department of Agricultural ready in 1889 to take up recommendations of Famine Commission as to Agricultural Improvement

6 In 1888 the Imperial Department having, in accordance with the Famine Commissioners' scheme (emphasised, as it was, by the Secretary of State), established Provincial Departments [illegible] means of the Famine [illegible] having, lastly, by the [illegible] for maintaining agricultural statistics for the administration of Land Revenue and the collection of agricultural information, they announced their work to be in a sufficiently advanced state to enable them to take up the remaining section of the Famine Commissioners' recommendations, *viz*, that referring to agricultural improvement. In connection [illegible] al Chemist was once [illegible] by the Government [illegible] n by the Secretary of State to give effect to the recommendations of the Famine Commissioners in relation to agricultural improvement still rested upon them, and that so long as they were not relieved from this obligation it remained in full force; further, that the other recommendations having been provided for and financial pressure having become less severe, they were now prepared to turn their attention to agricultural improvement. Still later (1889), the Home Department, by their Resolution on Technical Education, imposed upon both Agricultural and Educational Departments the further obligation to "take positive measures for the education of the rural classes in the direction of agriculture" Consequently the Agricultural Departments, Imperial and Provincial, have at the present time before them the positive duty of promoting both Agricultural Improvement and Agricultural Education.

Resolution of Home Department on Technical Education 1889 obligation on Agricultural Departments to promote Agricultural Improvement and Agricultural Education

Further application for Agricultural Chemist, July 1889

7. The Delhi Conference, before mentioned, had strongly represented the necessity of having at least one first-class Agricultural Chemist for India, and had urged that the employment of such a man in connection with the expansion of the Forest School at Dehra, and with the College of Science at Poona, would be desirable for educational purposes, his time, when not engaged in the actual work of teaching, being devoted to agricultural enquiry. These views were endorsed in a despatch to the Secretary of State, dated July

Reply of Secretary of State to application

21st, 1888. In reply, the Secretary of State, after seeking the opinions of the late Sir James Caird and Mr Thiselton Dyer (opinions, it may be said, in several respects divergent, but agreeing as to the undesirability of making teaching a main point in the duties of such a man as might be chosen), expressed himself still unable to agree to the recommendation urged on him, and asked for further explanation This the Government of India gave in their reply of June 1st, 1889, pointing out in detail the various classes of Natives for whom education in agriculture was desirable, and reiterating the necessity for systematic scientific enquiry in agriculture

Sanction given to enquiry by expert August 1889

8 The Secretary of State, though not prepared without further investigation to accept these proposals, expressed his willingness to send out a competent Agricultural Chemist who should make enquiries in India itself, and (in the words of the despatch of November 7th, 1889) "advise upon the best course to be adopted in order to apply the teachings of "Agricultural Chemistry to, and in order to effect improvements in, Indian agriculture" The selection of an expert was entrusted to Sir James Caird, who himself had been one of the Famine Commissioners.

Selection of myself by Sir James Caird

Sir James Caird did me the great honour of mentioning my name first, and in preferring on behalf of the India Council the request to the Royal Agricultural Society of England for the use of my services, he expressed the hope that the Society (of which he was himself one of the oldest members) would, in view of the importance and national character of the work, see their way to allowing me to undertake it, and to grant me the necessary leave of absence from my post as their Consulting Chemist

Leave of absence granted by Royal Agricultural Society of England

The Society, on their part, heartily granted the request made by Sir James Caird, and my delegation to India was ratified by the India Council

Arrival in India December 10th 1889

Accordingly, on November 21st, 1889, I left London *en route* for Bombay, and arrived in India on December 10th

Purposes of my mission

9 The purposes of my deputation were thus defined by the Secretary of State

To enquire into and advise upon—

1st.—The improvement of Indian Agriculture by scientific means

2nd —The improvement of Indian Agriculture generally

My method of enquiry

The method of enquiry I followed was, first to acquaint myself as far as I could, by travel, with the agricultural conditions of the country, as exemplified in selected tracts of a typical character, to visit all Experimental Stations and also the principal experiments conducted in the past by Government or by private indi- [illegible] ltural teach- [illegible] free discus- [illegible] ver inform- ation and suggestions I could as to the agricultural needs of the country Taking one district specially, the Cawnpor

the [illegible]
sys [illegible]
at [illegible]
agr [illegible]
nected with coffee, tea, indigo, and jute growing, and into systems of Irrigation, of Grass Farms, and of Forest Administration.

My tours

10. My travels were mainly divided into two tours—the first from December 10th, 1889, when I arrived, until May 19th 1890, when I reached Simla [illegible] tion during the co[illegible] September 12th, [illegible] country during th[illegible] between the tours, [illegible] putting together the notes of my first tour, of consulting all officials connected with the Agricultural Department, and others interested in agriculture, and I also had free access to the records and library of the Department. I further drew up a brief summary of the conclusions I had arrived at up to that time, and these, under the name of "Preliminary Notes," were circulated privately, and were subsequently discussed at the Agricultural Conference held in October 1890 at Simla On returning to Simla, after the conclusion of my second tour, I proceeded with the compilation of fresh information and the arrangement of the material I had already gathered for the purposes of my Report. The assembling of the Agricultural Conference at Simla, October 6th to 13th, after Sir Edward Buck's return from furlough, gave me the opportunity, of which I was glad to avail myself, of submitting my views to the consideration of the members composing the Conference, and of hearing their opinions and noting their suggestions Leaving Simla in November, I made a short third tour before reaching Calcutta, and finally left India on January 10th, 1891, having been just thirteen months in the country. Thus, omitting Burma and Assam, which were not included within the scope of my enquiries, I was able [illegible] different Provinces twice, with [illegible] nce in the cold weather and on [illegible] Punjab the season had advanc[illegible] to enable me to see the cold-weather crops, except just in the neighbourhood of Delhi.

Agricultural conference at Simla October 1890

Expression of sense of obligations

11 The duty now devolves upon me of putting together my conclusions and suggestions, based upon what I was able, in the time at my disposal, to see of the agriculture of the country, what I have gathered from the literature of the subject, and, above all, what I have gained from the experience of the many officials and others it has been my privilege to meet, and who have been always ready to assist me in every way possible. In the account of my tours I shall duly acknowledge the help that individuals have so kindly rendered me, but I must not pass on without mentioning some special obligations I owe.

Among the first I must name the late Sir James Caird, to whom I was indebted for my selection, and who gave me much advice derived from his own experience in India, and his acquaint

ance with its officials since, then Sir James Peile, of the India Council, and Sir Charles Bernard, of the India Office. Sir James Peile had charge in the Council of the matter of my delegation, and Sir Charles Bernard made the arrangements for my visit, and assisted me much by advice and suggestions, as also, after my return, in the issuing of my Report

On the voyage out it was my good fortune to meet Mr Robert H Elliot, of Clifton Park, Kelso, well known both as a Scotch agriculturist and as a coffee planter in Mysore, and besides as an able writer on Indian agricultural matters From him I learnt much that was afterwards invaluable to me.

In India, I must specially name Sir Edward Buck, Secretary the Revenue and Agricultural Department of the Government of India, who took a deep personal interest in my mission, and provided for me every facility for making my investigation a complete and independent one. Sir Edward himself arranged for me an extended tour, and commended me everywhere to the officials of his Department throughout the country, so that I was able to see everything to the best advantage Besides losing no opportunity of making me acquainted with the work of the Agricultural Department in the past, as well as with its objects and aims in the future, Sir Edward himself took me on my first tour to the North-West Provinces, and then on to Berar, Indore, and Bombay.

Next, I would express my indebtedness to the several gentlemen, mostly Directors of Provincial Departments of Land Records and Agriculture, who arranged tours for me in their respective Provinces and who themselves personally conducted me throughout, providing in every way for my comfort, and ensuring that in the time at my disposal I should see, not only as much as possible, but also what it would be most advantageous to see To them my sincere obligations are due, and I have ever-fresh recollections of much pleasant acquaintance with them, and of kindnesses received from them. These are —

* Mr. J. B Fuller (Central Provinces)
* Mr E C Ozanne (Bombay)
* Mr T W. Holderness (North-West Provinces and Oudh)
* Mr. M Finucane (Bengal).
* Mr F. A. Robertson (Punjab).
Mr. C Benson (Assistant Director, Department of Agriculture, Madras)
Mr Muhammad Husain (Assistant Director, Department of [illegible] inces and Oudh)
[illegible] ctor General of Forests)
[illegible] Upper India Chamber of Commerce, Cawnpore)

* Directors of Provincial Departments of Land Records and Agriculture

I have further to express my thanks to His Excellency the Viceroy (Marquis of Lansdowne) for much personal kindness

shown to me, and interest taken in my mission, as evinced in the several interviews graciously accorded me, to Their Excellencies Lords Reay, Harris, and Connemara, whose guest I have been at different times, and to the following Members of Council and Governors of Provinces for kind suggestions and advice Sir Auckland Colvin, Sir James Lyall, Sir Steuart Bayley, Sir David Barbour, Sir Geo Chesney, Sir Charles Elliott, Hon Mr (now Sir Philip) Hutchins, Messrs Stokes (now Sir Henry Stokes), Garstin, and Clogstoun, of Madras, and Mr. A. (now Sir Alexander) Mackenzie

There are many other officials to whom my thanks are similarly due for much assistance rendered me in my enquiries, notably Colonel Forbes, Mr. Harvey James, General Badcock, Mr. W C Benett, Mr P. Nolan, Mr. Justice Jardine, Mr H. E M. James, Colonel Ardagh, Mr. F Henvey, Dr. Geo King, Dr Geo Watt, Mr J E O'Conor, Mr Duthie, Colonel Pitcher, Colonel Marriott, Colonel F Bailey, Major Chibborn, Mr. W. J. Wilson, Dr. Theodore Cooke, Major Elliott, Major Wingate, and the late Mr S A. Hill.

Among the most pleasurable recollections of my tours will be those associated with the visits I paid to agriculturists, planters, and others to whom I was commended, and who everywhere showed me the greatest hospitality It is impossible here to record the names of all, though they are well remembered by myself, but I must mention as representative,—Mr. R H Elliot of Mysore, Messrs W. B Hudson, J. J Macleod, and T M. Gibbon of Behar, Captain Chapman (Oudh), Captain Goad (Hapur), Messrs Thomson and Mylne (Beheea), Mr Macdonell (Serajgunge), Mr G W. Christisson (Darjeeling), Dr. Hendley (Jeypore), and, in the Punjab, Messrs C. B Francis, E B. Steedman, J. A Grant, H. C. Cookson, Captain Marrett, Major Massy, and Dr. Warburton

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shown to me, and interest taken in my mission, as evinced in the several interviews graciously accorded me, to Their Excellencies Lords Reay, Harris, and Connemara, whose guest I have been at different times, and to the following Members of Council and Governors of Provinces for kind suggestions and advice Sir Auckland Colvin, Sir James Lyall, Sir Steuart Bayley, Sir David Barbour, Sir Geo. Chesney, Sir Charles Elliott, Hon Mr (now Sir Philip) Hutchins, Messrs Stokes (now Sir Henry Stokes), Garstin, and Clogstoun, of Madras, and Mr. A. (now Sir Alexander) Mackenzie

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CHAPTER II.

PRELIMINARY REMARKS ON THE POSSIBILITY OF IMPROVING INDIAN AGRICULTURE

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Danger of making general remarks on Indian agriculture

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Complexity of the subject

Erroneous opinions entertained in regard to Indian agriculture

14. On one point there can be no question, *viz*, that the ideas generally entertained in England, and often given expression to even in India, that Indian agriculture is, as a

whole, primitive and backward, and that little has been done to try and remedy it, are altogether erroneous. It is true, as indicated above, that no matter what statement may be made, as deduced from the agriculture of one part, it may be directly contradicted by a reference to the practice of another part, yet the conviction has forced itself upon me that, taking everything together, and more especially considering the conditions under which Indian crops are grown, they are wonderfully good. At his best the Indian *raiyat* or cultivator is quite as good as, and, in some respects, the superior of, the average British farmer, whilst at his worst it can only be said that this state is brought about largely by an absence of facilities for improvement which is probably unequalled in any other country, and that the *raiyat* will struggle on patiently and uncomplainingly in the face of difficulties in a way that no one else would

Nor need our British farmers be surprised at what I say, for it must be remembered that the natives of India were cultivators of wheat centuries before we in England were It is not likely, therefore, that their *practice* should be capable of much improvement What does, however, prevent them from growing larger crops is the limited facilities to which they have access, such as the supply of water and manure But, to take the ordinary acts of husbandry, nowhere would one find better instances of keeping land scrupulously clean from weeds, of ingenuity in device of water-raising appliances, of knowledge of soils and their capabilities, as well as of the exact time to sow and to reap, as one would in Indian agriculture, and this not at its best alone, but at its ordinary level It is wonderful, too, how much is known of rotation, the system of "mixed crops," and of fallowing Certain it is that I, at least, have never seen a more perfect picture of careful cultivation, combined with hard labour, perseverance, and fertility of resource, than I have seen at many of the halting places in my tour Such are the gardens of Máhim, the fields of Nadiad (the centre of the "garden" of Gujarat, in Bombay), and many others.

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Preliminary Remarks on the possibility of improving Indian agriculture

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The first aim in any scheme of agricultural improvement should, I think, be to modify those differences which exist, first of all, by teaching, in the more backward parts of India, the better practices of the most advanced Indian agriculture, and, secondly, by supplying, wherever it is possible, those facilities which exist in the best agricultural districts It is in the existence of these differences that there is a warrant for belief in the possibility of improving Indian agriculture, and it is in the modification of them that the greatest hope of improvement lies Apart, therefore, from the question whether the agriculture of the country can be improved by the introduction of more scientific methods from the West, I believe the first step must proceed in the direction of improvement from *within*, in other words by the modification of those differences in agricultural conditions and practice that exist in different parts of India itself

Their existence the ground for possible improvement in agriculture

I shall now proceed to enumerate these differences, and shall then show how, in my opinion, they may be most easily modified

18. The differences appear to me to range themselves into three separate classes, and, after naming these, I shall proceed to briefly indicate, in a general way, the direction which modification of differences, where possible, may be looked for In subsequent chapters I shall deal with each sub division separately.

Three classes of differences

The three classes are :—

I. Differences *inherent to the people themselves* as cultivating classes—

I Differences inherent to the people themselves

for instance, the fact that, by hereditary practice, certain castes and races are bad, others are good cultivators

II Differences *arising from purely external surroundings*, and not directly from any want of knowledge These may be subdivided into—

II Differences arising from purely external surroundings—

(*a*) physical causes—

(a) physical causes

such are —climate, soil, facilities for water, manure, wood, grazing, etc ,

(*b*) economical or political conditions—

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such are —the relative ease or difficulty of living, paucity or pressure of population, etc

III Differences *arising directly from want of knowledge*—

III Differences arising directly from want of knowledge

for instance, the existence of diversity of agricultural practice in different parts of the country

19 Having stated the differences, it is desirable to consider in the next place the means by which they may be removed, or at least be modified

Agencies by which improvement is to be effected

This I can best put in the form of three propositions :—

1st The modification of existing differences in agricultural practice and methods must proceed from positive measures taken—

(*a*) by the people themselves;
(*b*) by the Government.

2nd So far as it is possible for Government or for Agricultural Departments to assist in the modifications of these differences, it is their duty to do so

3rd. It is the work of Government to test Western practice and the applications of modern science, as also to introduce them when found suitable for India.

Illustrations of differences

20. It will be well now to illustrate the foregoing differences, and, in indicating how their modification may be carried out, to give, at the same time, a sketch of the method I intend to adopt in the succeeding chapters of this Report.

I. Differences inherent to the people themselves

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It is well known that certain castes and races have been prevented by religious prejudices or "historical causes" (to use Sir Charles Elliott's expression) from adopting the more skilful or more laborious systems of cultivation in vogue among other castes or races Thus, the Rájputs, Brahmans, Kolis, and Kols may be mentioned as hereditarily inferior as cultivators to the Jats, Kurmis, Lodhas, Káchhis, and others. Here it is not so much that the external surroundings are unequal, nor that the agricultural knowledge is at fault, but the real cause is found in the inherent differences of the people themselves Side by side, in the same village, one may, for instance, see both superior and inferior husbandry, the explanation being found primarily in a reference to the respective caste of the cultivator in each case. In Behar I once saw a quantity of dung lying about in heaps on a field not spread out, but, between the rain and the sun, speedily losing its goodness. It had been lying about so for a considerable time. On asking a neighbouring cultivator why the owner did this, the reply was, "He is only a goatherd," meaning thereby that he did not belong to a good cultivating class Here the people of this caste evidently required to be taught better methods of agriculture, and how to manage properly the manure at their disposal.

The remedy can be by the people themselves.

The modification of such differences (to revert to my propositions in paragraph 19) will, in some cases, be effected by the people themselves in the gradual abandonment of their prejudices

and the adoption by them of more profitable practices A change of this kind has been seen in the adoption of indigo cultivation by castes who formerly used to consider indigo an unclean thing Another instance is the extension of cultivation of the potato, against which a religious prejudice existed on the ground that it was "flesh" The work that Government can do, and the duty that should be its, is to assist in raising the level of the people through the spread of Education This will continue to do, as it has already done, a great deal to break down prejudice Further than this the Government can do little, if anything

Their modification by the *Government* through Education

II. *Differences arising from purely External Surroundings*

II Differences arising from external surroundings—

(*a*) *Physical Causes*—These may be subdivided into—

(*a*) physical causes

(i) climate and soil,

(ii) facilities for water, manure, wood, grazing, etc

(i) These two—climate and soil—stand in a different category to the others They are fixed by geographical and geological considerations, over them neither the people nor Government have more than a limited control, and consequently comparatively little can be done to modify the differences For instance, it is not possible to compare agriculture under the influence of a damp climate and abundant rainfall, such as prevails in the greater part of Bengal, or below the Western Ghâts of Bombay, with that of the dry parched plains of Multan and elsewhere in the Punjab Equally impossible is it to find a resemblance between the rich black cotton soil of Berar or the Central Provinces, and the sandy soils of Sirsa, or other parts of the Punjab The planting of trees may indirectly modify the rainfall, and plentiful manuring may improve the poorer soil, but they will be powerless to make the one locality or soil really like the other

(i) climate and soil Modification of these differences only possible within limits

(ii) Here we have a set of physical causes giving rise to differences which, unlike those in the case of climate and soil, it is in the power, both of individuals and of Government, to mitigate to a considerable extent.

(ii) facilities for water manure wood grazing etc.

Marked indeed are the differences between parts plentifully supplied by wells, or through which streams or canals flow, and those, where these *features are absent, so, again, the differences are* great between treeless tracts and those in which

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The modification by the people themselves.

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Here the change will only come with the inevitable disturbance which time and increasing population will cause in the easier circumstances under which the people in some parts live at present, as compared with those in others

The lessening of these differences.

III *Differences arising directly from want of Knowledge*

III Differences arising directly from want of knowledge

There are many instances of the cultivation of one district being inferior to that of another, not on account of caste differences, nor yet on account of external and unfavourable physical surroundings, but simply because a better practice—I speak of Indian, not English, practice—has not been known Or, again as I shall have cause to show, an implement is not in use in a district, though employed advantageously elsewhere, or cattle are poor because not properly fed, or manure is wasted (more especially the urine) because there is no litter to conserve it, or crops are inferior in yield because seed is not carefully selected

Their modification by the State— (a) by Education (b) by transference of agricultural methods

The want of knowledge, and the lessening of the local differences arising therefrom, cannot be supplied *directly by the people themselves, but they may be by* the State, partly by means of Education, and partly by the introduction of better methods from localities where they are known to those where they are unknown, but their application to which is both feasible and desirable

Need of agricultural enquiry insisted on in Government of India's Resolution of December 1881

This cannot be done without that "systematic prosecution of agricultural *enquiry*" which is so strongly insisted on in the Goverment of India's Resolution of December 1881, and which, as is rightly urged, "must precede any attempt at agricultural "*improvement*"

Duty of Agricultural Departments to institute enquiry

It is the positive duty of Agricultural Departments to acquire a thorough knowledge of, and acquaintance with, the agricultural facts of each Province with which they have to deal

The agency required

Such an enquiry, to anticipate my final recommendations, can, as the foregoing Resolution indicates, only be efficiently carried out by "a permanent agency "closely associated with the existing authorities in "each Province" Further, as I shall point out in subsequent chapters I think that the assistance of an expert with special knowledge of the application of chemistry to agriculture is desirable in any such enquiry

2

CONCLUSIONS

21. Owing to the great diversities met with in India, not alone in the physical features of the country, but also in the people themselves and in their varying surroundings, it is very difficult to speak generally of the condition of the agriculture. While in many parts it may undoubtedly be possible to effect improvement, it is not possible to do much, if anything, in others. Moreover, in every case it will be necessary to enquire carefully into existing conditions and practice before any real improvement can be carried out. That differences of conditions and practice do exist, constitutes, in my opinion, a ground of belief in the possibility of improvement, and it will be by the modification of these differences, and the transference of indigenous methods from one part of the country to another, rather than by the introduction of Western practice, that progress will be made and agriculture be bettered. This work will be done, (*a*) slowly by the people themselves, as they gradually come to see the necessity or the advantage of adopting the more profitable methods, (*b*) more quickly by the State in the spread of Education, whereby prejudice will be broken down, and the benefit of better methods be made known. The introduction of such Western practices as may be found suitable to the case of Indian agriculture must also be the work of Government. Certain positive measures, such as the digging of wells by the people, the construction of tanks, etc., when found to be suitable, should be more persistently encouraged by the State, while major works, such as the making of canals, the provision of timber, fuel, and grazing, must be carried out by the State itself.

As a preliminary, however, to obtaining any real knowledge of the agricultural condition and needs of any district, there must be "a systematic prosecution of agricultural enquiry," such as is insisted on in the Government of India's Resolution of December 1881, and to this end there should be a permanent agency for the purpose in each Province. Lastly, I think that in any such enquiry the assistance of an expert with special knowledge of the application of chemistry to agriculture would be very desirable.

RECOMMENDATIONS

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22 I recommend, therefore —

The spread of General and Agricultural Education

The establishment of an organised system of Agricultural Enquiry

The active prosecution of positive measures already ascertained to be beneficial, and their further encouragement by the State

I proceed now to consider, in reference to the subjects indicated in paragraph 18, the agricultural conditions of the country as they have presented themselves to me, giving at the close of each section such suggestions for improvement as appear practicable

CHAPTER III.

CULTIVATING CLASSES.

CULTIVATING CLASSES.

23 As mentioned already, there are great differences between the various castes and races of India in respect of their cultivating abilities, differences which are inherent to the people themselves, and which are consequently difficult to level. Yet the very existence of these differences gives a decided encouragement to the belief in the possibility of improvement, for it would proceed on what, after all, are the right lines when dealing with Indian agriculture, *viz.*, to improve it from within, and by means of its own examples, rather than by bringing foreign influences and methods to bear upon it The fact that a cultivator in one place, or, better still, in the same village, can act as an example to another elsewhere or co resident, may provide, if rightly followed up, a far more useful and less expensive practical proof of the possibility of improvement than a Government Experimental Farm. I remember being much struck by seeing, amidst the numerous wheat fields surrounding a village in the Central Provinces, a small holding of an acre or two, where, unlike elsewhere [illegible] The crops here were far more varied [illegible] growing, [illegible] was being utilised for a wheat crop situated [illegible] e holding I measured the standing corn, and found it to be then (February 23rd) 3 feet 8 inches high, whilst the wheat on unirrigated land adjoining [illegible] feet 1 inch high On enquiry I found that the holdin[illegible] and when I expressed [illegible] le, the answer given me was, that they [illegible] and that it was not their "custom" to grow other crops. Although necessity had not yet obliged others to adopt an improved practice, there was an instance afforded here of what might be done if the necessity arose, the improvement having its origin in a purely native source.

Castes and races.

24 The subject of "caste" is one of much complexity, and demands for understanding it a very extensive knowledge of the country. I can, therefore, say but little about agriculture in its relation to, and as affected by, caste. As mentioned in paragraph 20, some castes are hereditarily inferior as cultivators to others, but the agricultural practice of any one caste is not uniformly alike everywhere, nor equally good The Jâts, for example, are spoken of in the Meerut district as being "unsurpassed as cultivators," but

[illegible]

in the Bareilly district they are not so good, and the Kurmis and Lodhas are superior to them there The Rajputs and Brahmans do not themselves, as a rule, cultivate, but they employ hired labour, in some parts, however, they are described as being "moderate cultivators" Not only are there differences of caste, but there are also differences of race, as exemplified in the Kols (the aborigines of Chota Nagpur), the Bhils of Bombay, and others. Again, there are castes and races distinguished for the special branches of agriculture which they practise, or for the particular methods they employ, such are the Koeris, who are mostly growers of vegetables, the Kurmis, Lodhas, and Malis, who are largely market gardeners, the Káchhis, who, in their cultivation, use the night-soil of villages and towns, the Vellola caste, again, are cattle breeders, the Gavlis are suppliers of milk, and also breed their own cattle, the Gujars, Vanjaris, and others are graziers

25. Bearing in mind the method set forth in the last chapter, I shall confine myself to considering how far improvement in agriculture may be effected through the lessening of those differences which are directly due to caste or race prejudices The further question of the improvement of the cultivation of one locality by the importation into it of the practice of another, is one not directly connected with the inherent differences of cultivating classes as such, and will be dealt with elsewhere

Method pursued in this chapter

26. That the breaking down of caste prejudice would be followed by considerable improvement in agriculture admits of no doubt, and needs but little discussion Could the Rajput or Brahman be brought to see that there was nothing derogatory in manual labour, or in taking an interest in the cultivation of the soil, could other cultivators be led to follow the practice of the Kachhis, and abandon their prejudices against the use of night-soil as a manure, they could then raise crops such as the Káchhi does, and the country would be greatly benefited thereby.

Breaking down of caste prejudice would be followed by improvement in agriculture

In the course of my first tour Sir Edward Buck pointed out to me a village, named Singhouli, in the Doab, where the former tenants, who happened to belong to a low caste (Kurmi), had worked so industriously and profitably that they had actually been able to buy out the original proprietors who were of higher caste (Rájput), and had become possessors of the village themselves

The town of Farukhabad, again, is surrounded by a perfect garden, the result entirely of Kachhi cultivation When, about twenty years ago, Sir Edward Buck transferred some of these cultivators from Farukhabad to Cawnpore, they showed at the latter city how a profitable use could be made of what would otherwise have been a public nuisance, and also how the State revenue derived from the area they cultivated could be very largely increased

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I measured the standing corn, and found it to be then (February 23rd) 3 feet 8 inches high, whilst the wheat on unirrigated land adjoining was only 2 feet 1 inch high. On enquiry I found that the holding belonged to a man of the Káchhi caste; and when I expressed wonder that other cultivators did not follow his example, the answer given me was, that they were "wheat growers," and that it was not their "custom" to grow other crops. Although necessity had not yet obliged others to adopt an improved practice, there was an instance afforded here of what might be done if the necessity arose, the improvement having its origin in a purely native source.

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How breaking down of prejudice may be brought about—
(a) by the people themselves
(b) by the force of circumstances
Indications of a change going on

27. The breaking down of caste prejudice in agricultural matters may proceed slowly from the people themselves in the gradual abandonment of inferior practices in favour of more profitable ones; but it will be brought about more rapidly by the force and exigencies of circumstances which call for greater attention being paid to the cultivation of the land. Already there are indications of a change going on. It has been mentioned [illegible] by castes who used for- [illegible], and that the prejudice [illegible] also largely disappeared.

Some eight or ten years ago a batch of Káchhis from the North-West was transferred to Nagpur, in the Central Provinces. Not only did they continue to employ their particular practice with profit, but other cultivators around followed their example, amongst these being even Brahmans. The latter began to grow sugar-cane and vegetables of all kinds, just as the Káchhis had done. Their cultivation is still inferior to that of the Káchhis, but, nevertheless, a beginning has been made in the way of improvement, and this has originated entirely from the example set by the Káchhis. I might instance, too, the sugar cane cultivation around Poona. This was commenced by a Brahman who first showed the Municipality how to make "poudrette" out of the night-soil of the town, and then taught the Hindu cultivators how to use it. The "poudrette" is now used to an enormous extent. At Nagpur, again, I saw Brahman lads engaged in cultivating, they work with the plough just like the other pupils of Mr. Fuller's Agricultural Class; indeed, Mr. Fuller makes it a *sine quâ non* that they should do so.

In the Kapurthala Administration Report for 1890, page 36, Major Massy writes: "The Rájput is proud, idle, and not "thrifty . . . but still is a better cultivator than his fore-"fathers were, he goes out to his fields more regularly and "begins to realise that he must earn his living by the sweat "of his brow." In the Hoshiarpur Settlement Report it is stated that some of the Brahmans and Rájputs will now plough their lands with their own hands.

Thus it is clear that a change is going on.

Progress of improvement

28. The work of improvement by example may be, and probably will be, a slow one, and where circumstances (as in the case I have cited from the Central Provinces) do not call for the positive necessity of arousing themselves to better their agriculture, the higher castes or the [illegible] hold to their old ways; still, [illegible] wherever pressure has begun to [illegible] classes to adopt the practice of the superior and more thrifty ones. [illegible], as a [illegible]. where, [illegible] vegetable-growing and market gardening are now carried on most extensively, and almost entirely by the utilisation of the night-

soil of Amritsar as manure, in conjunction with canal irrigation. It would, not long ago, have been considered impossible for this to happen, or for night soil ever to be turned to a profitable use, on account of the prejudices of the people against it These prejudices still exist in many places, but I am convinced that they must give way, as they have done already, especially when the necessity of increasing the yield of the land is forcibly brought home

Improvement by force of example is not confined to native methods only, for, as Mr. R H Elliot pointed out to me, coffee planting by the Natives has improved very considerably in Mysore since European planters settled in the country and introduced better systems. The same remark applies to the cultivation and manufacture of indigo since English planters came to the districts where the plant is grown.

29 While the remedy for inferior cultivation will be found largely in the exigencies of circumstances which demand more attention being paid to the land, *it is in the weakening of* those caste prejudices which account, in no small measure, for the differences between good and bad cultivators, that Education plays a most important part Already its influence has been felt I have noticed above the case of the Nagpur Agricultural Class, and I might say the same in regard to the Poona College of Science and other institutions which I have visited The *spread of Education will be one of the most potent factors* in creating that interest which agriculture, from its wide-spread extension and importance as the staple industry of the country, both merits and demands It is, therefore, through Education that Government can aid largely in lessening those differences which are at present inherent to the cultivating classes as such, and which stand in the way of agricultural improvement

The influence of Education

The work of Government.

CONCLUSIONS

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30 Improvement in agriculture, through the modification of differences due to caste and race prejudice, may be effected by the gradual breaking down of that prejudice. This will result partly through the people themselves, in their adoption of more profitable practices, partly from the force of circumstances obliging greater attention to be paid to the cultivation of the land.

Government can greatly aid, through the spread of Education, in weakening caste prejudice.

RECOMMENDATION

RECOMMENDATION.

31. My suggestions under this head accordingly resolve themselves into—

The desirability of extending General and Agricultural Education.

CHAPTER IV.

CHAPTER IV.

CLIMATE.

CLIMATE.

32. This all-important factor in Indian agriculture is, unfortunately, one that can only be altered or modified to a limited extent. Interesting, therefore, as a study of the influence of climate on agriculture may be, we should, nevertheless, be dealing with one of those elements which the cultivator finds *in limine*, and in accordance with, and not in opposition to which he must frame his practice, because neither his energy nor the help of the State can to any great extent modify its conditions. It will, therefore, not be necessary f[illegible] the subject beyond touching on [illegible] ct produced on the practice of [illegible]

Effects produced by climate on the crop seasons

33. As explained in the "Statistical Atlas of India," it may be said that over the greater part of India there are three well-marked seasons, *viz.*, the rainy season (June to October, inclusive), the cold season (November to February, inclusive), and the hot season (March to May, inclusive). The two former are due, respectively, to the prevalence of the south-west and the north east monsoons, whilst the hot season marks the transition from the cold to the rainy season. Yet these alone do not determine the kinds of crops grown, and we do not find in all parts alike that there are crops corresponding to the different seasons. The relative dryness or dampness of the climate has also to be considered. Through the kindness of the [illegible] Government of Indi[illegible] illustrating the Ra[illegible] been specially reduced, by the Survey Department, from the corresponding maps in the "Statistical Atlas of India," and accompany the present Report. A reference to the Rainfall Map will here help to [illegible] mates [illegible] thern [illegible] with [illegible] erior; but in Northern India we find every variation, from the dry climate of the West and North-West, accompanied by marked differences of summer heat and [illegible] and heavy rainfall of [illegible] ences of temperature [illegible] whilst in the North-V[illegible] two clearly defined crop-seasons, *viz.*, the rainy season (*kharif*) and the cold season (*rabi*), we find that in Madras these distinctions

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Effects produced by the seasons.

disappear, and we have only early and late sowings of the same crops. In Behar and some other parts of Bengal there are three rather than two seasons, with their attending crops, *viz.*, the early rainy season (*bhadoi*), the late rainy season (*aghani*), and the cold season (*rabi*).

Great variation in rainfall of different parts as shown in Statistical Atlas of India

Relation of rainfall to famines

"Protected" and precarious tracts

34 The Report of the Famine Commission abounds with instances proving that famines are the result of one cause alone, *viz.*, failure of rainfall A reference here to the Rainfall Map will show how very varied is the distribution of rain over the country In Burma, Assam, Eastern Bengal, and along the coasts of the Western Ghats there is abundant rain, also a rain tract exists along the foot of the Himalayas In the Central Provinces, too, there is a plentiful rainfall. It is these parts, therefore, which are the most free from famine. So, again, but for a quite different reason, are the very driest regions of all parts of the Punjab, for example, since there the *raiyats* will never try to grow a crop or to cultivate unless there is a certainty of water supply. The most precarious tracts are those where the chance that enough rain may come *gives* a temptation to venture on *growing* a crop, and then, if drought intervenes, there is a total failure of harvest. These are the parts which are light-coloured on the Rainfall Map.

Illustrations of the effects produced by climate on the practice of agriculture in different parts

35 The dependence of certain crops on heavy rainfall and a damp climate is well marked in the case of tea culture in Assam, where the annual rainfall is from 90 to 160 inches or more, and in that of indigo in Behar, or of rice in Bengal and on the Western Coast of Bombay. Other crops, such as gram (*Cicer arietinum*) and *arhar* (*Cajanus indicus*), can, on the contrary, do with a minimum of moisture, and flourish in a hot, dry climate, such as that of the North-West Whilst the damp climate of Behar and Bengal favours the growth of the indigo plant but not the ripening of the seed, the hotter and drier climate of the North-West Provinces or the Punjab causes the seed to yield well there, and the two cultivations are, for the most part, carried on in separate Provinces With wheat growing we have marked contrasts of climatic surroundings, as shown, on the one hand, in the case of the plains of the Punjab and North-West Provinces, and on the other, in the wheat districts of the Central Provinces In the former, dependence is placed largely upon irrigation, for the soil soon loses its moisture and becomes baked, indeed, one may sometimes see (as I myself saw) a wheat crop on which not a drop of rain had fallen from time of sowing to harvest, so that, were it not for irrigation, famine might be ever at hand In the Central Provinces, on the

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nation of rainy-season (*kharif*) and cold-season (*rabi*) crops is not so common as in Upper India. The soils are of more marked diversity, and are better suited, some for rainy-season, others for cold-weather crops.

Going southwards, as I did in my second tour, from Delhi, through Rájputana, and down the western side of the Bombay

Presidency, along the north of Madras, then to Bengal, and returning finally to the Punjab, I had abundant opportunities of seeing how systems of agriculture must be varied according to the climate. Passing from the hot plains of Rajputana, with its sparse cultivation and low rainfall, one comes to districts of heavier rainfall, say 60 to 90 inches, such as Baroda, Nadiad, and Mahim, where rice will grow without irrigation, the rainfall alone sufficing; at Kalyan and Igatpuri (nearer Bombay) the rainfall varies from 100 to as much as 150 and 170 inches annually, and the *ráb** system of making the rice seed-bed is in vogue, whilst it is not employed in districts of lighter rainfall. Grass headlands and live hedges are also features of many of these parts. If, however, we go inland to the Khándesh (Deccan) district, we find a rainfall of but 30 inches and the crops quite different, rice being replaced by cotton and millets principally, wheat also coming in. On the southern side of the Bombay Presidency districts are successively passed in the journey by rail which have an increasing rainfall, from the Kistna Valley, where it is 40 inches, to Belgaum with 65 to 80 inches, while only another 20 miles or so further on it is as much as 150 inches annually. In each district the cultivation is different, rainy-season crops being distinctive of the first named, except where patches of black soil interspersed among the other (which is mainly red) enable moisture to be retained for growing cold season crops, such as wheat and gram. In Belgaum, as also in Dharwar, the exceptional feature of hot-weather rains in May allows of the early sowing of rice, for the heavy rains later on can always be depended upon, but *ráb** is not practised, whilst in the extremely rainy and unhealthy region nearer the Western Ghâts it is. On the red soil of Dharwar, with a rainfall of about 45 inches rice is, as mentioned, grown early, but on the black soil nearly all the cultivation is that of dry crops. Going on into the Madras Presidency, we find fresh factors regulating the crops that are grown, for not the south-west monsoon alone, but also the north-east monsoon plays an important part, and when the former fails, the cultivators wait for the second, and have thus a double opportunity of sowing. Again, in Madras there are not the wide divergencies of temperature that occur elsewhere, but a more regular and continuous warmth exists throughout the year, and so it may be said that the crops, to a considerable extent, go on independently of season. To pass from such conditions as these to those of the damp and hot climate of Bengal with its rice and jute and indigo growing, and then back again to the Punjab, implies seeing very great changes indeed in the agriculture. Even in the last-named Province, with variations of annual rainfall from the 7 inches found in the arid tracts of Multan and the 14 inches in Hissar, to the 20 inches of Amritsar, or the 35 inches of Hoshiarpur, the surroundings of agriculture must affect its practice vastly

* Ráb system.—Alternate layers of cowdung, loppings and leaves of trees, grass and earth are heaped up on the ground which is to form the seed bed, and the whole is then set fire to and the ashes mingled with the soil.

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35. The dependence of certain crops on heavy rainfall and a damp climate is well marked in the case of tea culture in Assam, where the annual rainfall is from 90 to 160 inches or more, and in that of indigo in Behar, or of rice in Bengal and on the Western Coast of Bombay. Other crops, such as gram (*Cicer arietinum*) and *arhar* (*Cajanus indicus*), can, on the contrary, do with a minimum of moisture, and flourish in a hot, dry climate, such as that of the North-West. Whilst the damp climate of Behar and Bengal favours the growth of the indigo plant but not the ripening of the seed, the hotter and drier climate of the North-West Provinces or the Punjab causes the seed to yield well there, and the two cultivations are, for the most part, carried on in separate Provinces. With wheat growing we have marked contrasts of climatic surroundings, as shown, on the one hand, in the case of the plains of the Punjab and North-West Provinces, and on the other, in the wheat districts of the Central Provinces. In the former, dependence is placed largely upon irrigation, for the soil soon loses its moisture and becomes baked; indeed, one may sometimes see (as I myself saw) a wheat crop on which not a drop of rain had fallen from time of sowing to harvest, so that, were it not for irrigation, famine might be ever at hand. In the Central Provinces, on the contrary, an abundant and regular rainfall, and a soil which retains that moisture firmly, make famine nearly impossible and do away with the necessity of irrigation. In the Central Provinces, further, alternation of rainy-season (*kharif*) and cold-season (*rabi*) crops is not so common as in Upper India. The soils are of more marked diversity, and are better suited, some for rainy-season, others for cold-weather crops.

Going southwards, as I did in my second tour, from Delhi, through Râjputana, and down the western side of the Bombay

Presidency, along the north of Madras, then to Bengal, and returning finally to the Punjab, I had abundant opportunities of seeing how systems of agriculture must be varied according to the climate. Passing from the hot plains of Rajputana, with its sparse cultivation and low rainfall, one comes to districts of heavier rainfall, say 60 to 90 inches, such as Baroda, Nadiad, and Mahim, where rice will grow without irrigation, the rainfall alone sufficing; at Kalyan and Igatpuri (nearer Bombay) the rainfall varies from 100 to as much as 150 and 170 inches annually, and the *ráb** system of making the rice seed bed is in vogue, whilst it is not employed in districts of lighter rainfall. Grass headlands and live hedges are also features of many of these parts. If, however, we go inland to the Khándesh (Deccan) district, we find a rainfall of but 30 inches and the crops quite different, rice being replaced by cotton and millets principally, wheat also coming in. On the southern side of the Bombay Presidency districts are successively passed in the journey by rail which have an increasing rainfall, from the Kistna Valley, where it is 40 inches, to Belgaum with 65 to 80 inches, while only another 20 miles or so further on it is as much as 150 inches annually. In each district the cultivation is different, rainy-season crops being distinctive of the first named, except where patches of black soil interspersed among the other (which is mainly red) enable moisture to be retained for growing cold season crops, such as wheat and gram. In Belgaum, as also in Dharwar, the exceptional feature of hot-weather rains in May allows of the early sowing of rice, for the heavy rains later on can always be depended upon, but *ráb** is not practised, whilst in the extremely rainy and unhealthy region nearer the Western Ghâts it is. On the red soil of Dhárwar, with a rainfall of about 45 inches, rice is, as mentioned, grown early, but on the black soil nearly all the cultivation is that of dry crops. Going on into the Madras Presidency, we find fresh factors regulating the crops that are grown, for not the south-west monsoon alone, but also the north-east monsoon plays an important part, and when the former fails, the cultivators wait for the second, and have thus a double opportunity of sowing. Again, in Madras there are not the wide divergencies of temperature that occur elsewhere, but a more regular and continuous warmth exists throughout the year, and so it may be said that the crops, to a considerable extent, go on independently of season. To pass from such conditions as these to those of the damp and hot climate of Bengal with its rice and jute and indigo growing, and then back again to the Punjab, implies seeing very great changes indeed in the agriculture. Even in the last named Province, with variations of annual rainfall from the 7 inches found in the arid tracts of Multan and the 14 inches in Hissar, to the 26 inches of Amritsar, or the 35 inches of Hoshiarpur, the surroundings of agriculture must affect its practice vastly.

* *Ráb system.*—A term: layers of cow-dung, loppings and leaves of trees, grass and earth are heaped up on the ground which is to form the seed bed, and the whole is then set fire to and the ashes mixed with the soil.

In the first-named district canals are absolutely necessary for the purpose of cultivation, in the last named the water level is quite near the surface of the ground In yet other parts, such as Hissar, where there is great want of water, and not sufficient for the sowing of winter crops, nearly all the crops are rainy-season ones

It is remarkable, too, how within quite a limited area the rainfall will vary The following instance has been given me by Mr. J J Macleod at Segowlie, in Behar, it is 80 inches yearly, at Rajghat, 9 miles to the west, 47 inches, at Beyreah, 5 miles west of Rajghat, 36 inches, and at Malljah, 5 miles south west of Beyreah, 26 inches, whilst at Dhodkrahar, 6 miles north of Segowlie, it is 66½ inches

Effects produced by climate on the cattle and people

36 But it is not in the crops alone that the influence of climate is seen, it is exemplified strongly in the case of the cattle and even in the people themselves It is only necessary to mention one single illustration out of many, *viz*, the wide difference between the diminutive bullocks and cows of Bengal, where a damp, hot atmosphere prevails, and the fine, large, strong cattle of Hissar and other dry parts of the Punjab In the latter Province the atmosphere, though hot is clear and dry, and the soil is far more adapted to the breeding of cattle than are the damp regions of Bengal We see, however, the reverse in the case of buffaloes, as no climate seems too damp or rainfall too heavy for them Thus, at Mahim (Thana district of Bombay) the buffaloes are magnificent but the other cattle are poor and miserable, so, too, is it in Eastern Bengal, in Behar, where it is drier, the plough cattle are again superior Buffaloes are the principal plough cattle throughout the districts of heavy rainfall below the Western Ghâts, here the preparation of the rice fields, covered as they are with water to the depth of several inches, could only be carried on by means of buffaloes. In the Punjab fine buffaloes may be seen, it is true, but it is as a milk giver that the animal is esteemed there, and its excellence depends upon the practice there in vogue, of growing fodder-crops for the cattle, and of driving the buffaloes to the forests or to the river banks to remain there during the hottest months of the year

What is true of the cattle in respect of diversity produced by climate is true also of the people The inhabitants of the dry, and at times cold, Provinces of North-Western India are far stronger and more active than those of the always damp and warm Provinces such as Bengal, although in these latter the people are the more mentally acute Their respective foods have undoubtedly also to do with these differences, but the foods themselves must be considered as determined by climate, for it is alone in the cooler and drier climate that wheat will flourish, while rice rejoices in a damp, warm climate such as that of Bengal

Elimination of differences resulting from climate impossible

37 I said at the opening of this chapter that climate is one of the external circumstances influencing agriculture, in which changes can only be effected to a limited extent It is im-

possible, therefore, to eliminate the differences that result from it, the most that can be done is to mitigate their influence. In two directions, possibly, there is some hope of doing this:— Mitigation of the differences—

Firstly,—by the supply of Canals and other means of Irrigation to the drier tracts of the country; (a) by irrigation

Secondly,—by the preservation of Forests and the creation of "reserves" of Wood and Fodder. (b) by preservation of forests and creation of reserves of wood and fodder

To such supplies as the last-mentioned the name of "Fuel and Fodder Reserves" is generally given, and will be used throughout this Report.

38. The beneficial influence of irrigation in dry tracts is obvious, but that resulting from the growing of trees needs some explanation. Beneficial influence of trees

It has been much debated whether forests and plantations do actually bring about an increase of rainfall or not. But I would point out that their real influence and value consist in their *lowering the temperature*, and thus causing moisture to be deposited where otherwise it would pass on. As a consequence of this, forests and plantations will cause rain to fall in gentle showers instead of in heavy and often destructive deluges. Thus, a given quantity of rain will be distributed over a greater number of days, and its value to the agriculturist will be thereby largely increased. The true test of the value of afforestation in this connection is, not so much whether the *total* rainfall be increased, but whether the *number of rainy days* be more. The dewfall is also increased in the neighbourhood of trees, and this has considerable agricultural importance, too.

It has not unfrequently been observed that in times of drought there has been plenty of rain in the clouds overhead; what was wanted was some agent to condense and "bring it "down." Trees would materially assist in performing this. Again, the difference between the action of a gentle rain and that of a heavy deluge is very marked; for, while in the former case the water sinks gradually into the soil, in the latter it rapidly runs off the baked surface of the earth, and very often causes much damage by the destruction of roads, the washing away of bridges, and the silting up of tanks.

Through the kindness of Mr. Robert H. Elliot, of Mysore, I am able to supply a practical illustration of the value of woods, and one which would show that, in regard to rainfall, a climate can be favourably influenced in about 25 years. Increase of rainfall in Neilgherries through tree-planting

Mr. Elliot, when in the Neilgherries in 1891, carefully examined, with the aid of Government officials, the Rain Records from 1870 to 1890. Previous to 1870 Ootacamund and its neighbourhood were nearly bare of trees, so much so that a photograph taken about that time has no resemblance whatever to the now thickly-wooded Station, the result of a large

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been established there a rainfall has appeared, whilst before this there was none It is impossible, however, to say how far this result is due to the planting of trees, and how far to the opening of the Suez Canal, which latter is known to have caused distinct climatic changes

When visiting Etawah (North-West Provinces) I went to see a plantation for the supply of wood and grass, this had been established about five years previously on land which was nothing more than bare ravine land The whole extent of the plantation was 7,000 *bighas* (4,375 acres) I was assured that the Station had not been so hot since the plantation had been formed, and, anyhow, it is very certain that the now wooded and grass-covered ravines are very much cooler than the former bare, open spaces were. At Jhansi I was told the same thing, and that since the introduction of the system of *bunding** the streams and planting the slopes with trees, the Station had been cooler 3 Etawah

I am reminded here of an old Sanskrit saying which describes the rainfall as being divided into twelve parts, and assigns them as follows "Six for the sea, Four for the forests and mountains, and Two for the land"

39 Though immense tracts of country have been denuded in the past, there are still considerable areas which can be taken up and rendered serviceable for climatic ends, and the Forest Department has stepped in none too early in the endeavour to save those wooded tracts which are still left From climatic considerations alone, the work of the Forest Department is, accordingly, of importance Work of Forest Department in this connection

40 In addition to the protection of forests, and the reservation of considerable tracts for the creation of "Fuel and Fodder Reserves," there are other minor measures which have often been urged by the Imperial Department of Agriculture, and which, while primarily supplying timber and fuel, also exercise a benefit in the provision of shelter, shade, and coolness in the immediate vicinity. Such are the growing of trees along canal banks and railway lines, and the encouragement of Arboriculture by the planting of trees along the sides of roads. Other measures for supply of shade and shelter Plantations Arboriculture

These matters will be more fully dealt with in Chapter VIII, *when considering the wood supply of the country*

41 But little help must be expected to come from the people directly, in the attempt to mitigate as far as possible the influence of climate. They are hardly likely to originate such measures as have been suggested, and they have not the means to carry them out Too often, it is to be feared, they will even oppose the taking of remedial action, at all events at the outset Such has been the case already with Forest preservation, and it will not be until they are convinced of the utility of the measures taken for their benefit, and for the improvement of their agriculture, that the The application of remedial measures must be undertaken by Government

* Bunding —Embanking, i e holding up the streams that would flow over the land during heavy rain by means of embankments on which grass is a[illegible] trees planted as well

people will accord their hearty support; the tendency with them will be, as it has been in the past, to clear and to destroy rather than to save and to plant Something may be done by way of encouragement in offering rewards for tree-planting, but it is clear that the work, both of irrigation schemes and of maintenance and creation of wood "reserves," must fall to the share of Government

Duty of Agricultural Departments to enquire where remedial action should be taken

It becomes, therefore, the duty of Agricultural Departments, first, to make a careful enquiry as to the localities in which measures for mitigating the severity of the climate are most needed, then, to ascertain what the nature of such action is to be, and how it may be best applied This can only be done efficiently by instituting an enquiry such as that I have drawn attention to in Chapter II, and by an "agricultural "analysis" such as is sketched out in the Government of India's Resolution of December 1881 (*see* paragraph 4 of the present Report)

CONCLUSIONS

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42 While the elimination of differences due to climate and affecting agriculture cannot be achieved, the mitigation of their influence is to some extent possible This may be done by increasing the means of irrigation to dry tracts, and by preserving and extending *"reserves" of wood and fodder* In these ways an improvement in agriculture may be brought about Both measures are the work of Government

RECOMMENDATIONS

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43 I recommend —

The extension of Canals and other means of Irrigation to the drier tracts.

The establishment, wherever possible, of "Fuel and Fodder Reserves"

The increase of Plantations along Canal banks and Railway lines.

The spread of Arboriculture

The instituting of Enquiry by Agricultural Departments as to where the above measures are needed, and how they may best be carried out

CHAPTER V.

SOIL.

Absence of scientific study of the soils of India

44. The soils of India have not, so far, been made the subject of careful or scientific study. A few analyses are recorded of the soils of particular spots, and on two of the Government Experimental Farms a practical analysis of the soil has been attempted by growing crops on them with the aid of manures in which certain chemical elements have been alternately given or withheld. This has, however, been done without a previous knowledge of the soil and its constituents having been gained, has not been definitely known how much of each chemical element was actually supplied in the manures; nor was there any subsequent soil analysis in order to see which constituents, and how much of each, had been removed by the cropping. Such experiments have a certain value, it is true, and may occasionally give some rough idea as to the needs or capabilities of a particular soil, but they fall far short of what may be gained by a systematic and scientific enquiry. I do not wish, however, to attach too high a value to the mere chemical analysis of soils as the index to all soil improvement, knowing well, as I do, the difficulties of interpreting the results aright, and, especially in the case of India, of applying the results in the form of recommendations that will be practically useful. It is not enough to ascertain that a particular ingredient may be wanting in a soil or be beneficial to a crop, but it is necessary, too, to know in what practical and most economical form that ingredient may be supplied, and whether, in effect, it will pay to apply it at all. In this respect India is very differently circumstanced to England, America, and other countries Not only is there an absence of large landowners, but the few wants and scanty means of the cultivators, and the smallness of the holdings (averaging probably less than five acres each), make it necessary to consider measures of improvement from a special point of view This has not been sufficiently borne in mind by those who have advocated "improved" implements and chemical manures for Indian agriculture Even those (and Natives, too) who have lived in England or have gone there to study have been disposed to exaggerate the value of chemical manures and chemical analysis of soils. While urging, as I shall do strongly, the employment of chemical and analytical skill in connection with the investigation of the soils of India, and in agriculture generally, I must not lead those whom I am called upon to advise, to expect too much from the researches of an Agricultural Chemist. Analysis of soils may do much to explain phenomena, and to suggest the lines of improvement, but it can, unaided, certainly not *reform* Agriculture. There is, however, without doubt, a large field open for enquiry, wherein the assistance of chemical

Need of caution in applying results of scientific enquiry to Indian agriculture

The real use of chemical analysis of soils etc

analysis will be positively necessary, but it must be employed in conjunction with an intelligent acquaintance with agricultural practice and with the needs and resources of the agricultural classes, an acquaintance which can only come from a careful and systematic course of enquiry.

Variation in main types of soil in India is not so marked as in England.

45 In respect of different geological types of soil India exhibits far less variation than England. Soils of one main character stretch unchanged over infinitely wider areas, and the differences found in England on a single farm, necessitating special treatment and the growing of particular crops on each kind of land, are not often met with in India Reference to the Geological Map given in this Report will show that the divisions are few in number and little varied over the country. They may be said to consist of three different kinds only, marked respectively on the map, brown (alluvial tracts), green (black cotton soil), and red (hard rock). The vast alluvial plains composed of mud and sand stretch across the northern portion of the country from west to east; the second type or black cotton-soil is a basaltic formation, and occupies mainly the central and western divisions of the map; lastly, the hard, rocky type, composed of archaean and metamorphic rocks, covers the southern and south-eastern divisions In the next chapter I shall have occasion to point out how the effect of irrigation is altered by the existence of these different kinds of soil. Peaty soils are but little known in India, the chalky gravels and oolite soils, the marls and clays and other varieties met with in England are absent, in their place are found distinctive types in the "black cotton-soil," in the presence of concretionary nodules of carbonate of lime called *kankar*, and in vast alluvial plains and silt renewed tracts

Geological Map in Statistical Atlas of India.

Types of soil.

Numerous sub-divisions of soils

Local classification.

46 Although the main geological types of soils are not so varied as in England, there are a large number of subdivisions, known by local names differing in each district, but the respective qualities of which are quite clearly understood by the cultivators These minor differences, the result of variations in climatic conditions, in the system of manuring, and in the greater or less prevalence of trees and forest in the neighbourhood, are more numerous in India than in countries of more uniform climate and more similar agricultural practice and surroundings throughout. In several Provinces a regular system of classification of soils exists, and is used for Settlement purposes, while each district has its own classification under the particular local names given to the soils in each In some Provinces every field even is classed according to its position, the nature and depth of the soil, the crops grown on it (whether it be wheat or rice or "garden" land), its nearness to the village site, etc., and particulars are recorded as to its being embanked, irrigated, or open to damage from water-channels, and whether it be exposed to injury from wild beasts, etc.

Desirability of instructing Revenue officials in agriculture

47. On one occasion when I was in the Central Provinces, several Inspectors of Village Accountants (*patwaris*) and District Inspectors came to me, and, as we went over the fields together, I was much struck by the minute discriminations which they made between different varieties of soil, and by the interest which they took in this part of their work. They were, however, quite ignorant as to how soil came to be formed, and of the forces of nature, and of the causes which produce differences of soils With a little sound instruction in agriculture, and in the elementary facts of science affecting it, these men would, I thought, have a much more intelligent understanding of agriculture, and of the conditions with which they have to deal in their daily work

Improvement of soil—the directions in which it may proceed.

48 I come now to the improvement of the soil. This must take one of two forms *first*, the rendering of cultivated land more productive, *second*, the reclamation of land, or the making fit for cultivation land which is now considered unculturable.

Is the soil of India becoming exhausted?

49 Under the first head the question naturally arises—Is the soil of India becoming exhausted? This is not an easy question to answer Time after time it has been pointed out to me that the same fields have gone on growing the same crops on much the same system as at present, for centuries past, it is averred, too, that, by rotation and fallows, the land receives the necessary change of cropping and the "rest" from cultivation which prevents it from going down in quality. Further arguments are, that the rainfall contains more nitrogen in India than in England, that the sun acts as a fertiliser, and so on. On the other hand, there is a pretty general belief that the soil *is* becoming less productive, and remarks to that effect occur over and over again in the Settlement Reports of most able officers, obliging one to conclude that they are more than mere casual observations

Want of positive evidence

When, however, one looks for positive evidence of soil exhaustion, I admit that it is not forthcoming Still, this does not prove that exhaustion is *not* going on The want of evidence is due rather to the absence of reliable records in the past, and to attention not having been paid earlier to the crop out-turns When the question as to whether the soil was deteriorating was asked by the Famine Commissioners, the reply received from Bengal was, that there were no means of ascertaining This same answer might with truth have been given by all the Provinces, for the whole of the replies received were very indefinite, and dealt with surmises and with popular report rather than with actual facts When investigating the subject myself, I hoped to find in Settlement Reports more definite information, deduced possibly from instances of assessment having been reduced, but, whilst a large number of instances are given where land had become unculturable owing to the spread of the efflor-

escence of soda salts known as *reh* * (the land so affected being called *usar*†), there are but few cases mentioned in which actual deterioration of soil through continual cropping is stated to have taken place. Where, in the absence of *reh*, assessment had been reduced, it is impossible to ascertain whether any of the many other influences, such as fall in prices of produce, want of rain, indebt
has
failu
about.

It is hard to gauge out-turns, and to get to know what the soil is, by itself, capable of producing or for what period the return from manured land will continue to differ from that of unmanured. Further, it has to be considered that as fresh land is broken up, the manure supply, always limited and insufficient, has to be spread over a larger area than before The opinion of cultivators must, I know, be taken as worth little, especially if it be *given at a time when a re-settlement is imminent*, *the other* opinions which I shall presently quote I give without wishing undue weight to be attached to them — Difficulty of deciding the question

On two points there is, however, decided agreement *firstly*, that land newly brought under cultivation yields well at first, but that, after a time, the produce falls, and *secondly*, that, whether the soil be undergoing exhaustion or not, it is certainly not being enriched, nor is the average out-turn over the whole cultivated area an increasing one This has led many to the conclusion that, while land newly broken up will yield largely for a time and then decline this decline will not go below a certain level, and there it will stop The instances of unmanured plots on the Experimental Farms at Rothamsted and Woburn in England have been quoted in support of this view, but these though they show that, after a certain level has been reached, subsequent deterioration goes on very slowly, yet prove that it does go on — Theory that soil exhaustion proceeds to a certain limit and then stops

The results obtained at Rothamsted in the case of a wheat crop continuously unmanured for 40 years are — — Experience at Rothamsted

	Average produce of Corn per acre in Bushels.
8 years 1844—51 (previous to commencement of experiment) .	17
20 years 1852—71 (experimental period) .	13·9
20 years 1872—91 , , .	11 1

That positive evidence of exhaustion in the soils of India is not yet forthcoming is no proof, therefore, that the process is not slowly going on

* *Reh*.—An efflorescence of soda salts, which appears as a white crust on the surface of the soil and renders it unculturable The salts are principally impure carbonate of soda but sulphate of soda also occurs largely and with them are found common salt and salts of lime and magnesia. *See* also paragraphs 67 and 74.

† *Usar*.—Land impregnated with soda salts as above and thereby rendered barren *See* also paragraphs 73—6

Instances in support of the view that exhaustion of soil is going on in India :—

50. I invite attention to the following instances which I have gathered, or which others have kindly collected for me :—

(a) from Coimbatore (Madras),

Mr Nicholson, in his "Manual of Coimbatore," says :—

"In Erode (Madras) the *dry* crops are usually poor, the *taluk* has been "widely cultivated, so that the land has had no rest, rainfall is variable and "partial, cattle are not abundant, and population is large so that the surface "soil (and there is but scanty soil on the uplands) is exhausted for want of "sufficient manure, most of which goes to the gardens"

Again :—

"The open sandy and treeless wastes south-east of Udamalpet, near the "foot of the hills, are melancholy instances of reckless tree destruction in "long distant periods, these were evidently rich jungles like those of "Anaimalai, but are now treeless and exhausted"

(b) from Gorakhpur (N W P)

In the Gorakhpur (North-West Provinces) Report is the following :—

" [illegible] ...ts favourably with that [illegible] that gradual deterio- [illegible] stem of over-cropping [illegible] is not maintained by [illegible] by a sufficient use of [illegible] l to prospective general [illegible] h has been the longest "inhabited and twenty years ago was said by Mr. Chester to be one of the "most fertile is now the least productive in the *pergunnah* and contrasts most "unfavourably with Tappah Seharree, of which the soil was lately virgin [illegible] ...nure"

(c) from Gonda (Oudh)

In paragraph 19 of the review of the Gonda (Oudh) Report is this :—

"There is no alternate root crop known to the husbandry. A large "amount of animal manure is diverted from the land and used for fuel . . . The natural consequence is that over-cropping in time exhausts "even the best soils, and the culture during a series of years is unduly "low"

(d) from Partabgarh (Oudh)

In the Purtabgurh (Oudh) Report occurs this :—

"The soil, though fertile, bears evidence of exhaustion through want of "manure and fallow seasons . . . . . . The root of the present "complaint, that the present yield is not equal to that of former times, lies "in the fact that under the native rule a field was seldom tilled for more "than two or three years in succession In the third or fourth year a plot of "waste was broken up, while the whole land was allowed to lie fallow. A "succession of rich harvests was the consequence Now, however, . . "competition steps in and prevents the resting of single acre"

(e) from Lohardaga (Bengal)

In the Report on the agriculture of Lohardaga Mr. Basu writes :—

"The fertility of the soil is being reduced fast to the permanent limit by "(1) continued cultivation without replacement by sufficient manure ; (2) "spread of cultivation (less forests and pasture less cattle, and bigger areas

"to be manured), (3) cattle epidemics The supply of manure is extremely "limited"

In another passage Mr. Basu says —

"Fallowing used to be done, but is restricted owing to pressure of "population

From the replies to enquiries addressed by the Famine Commission I take the following —

Central Provinces.—Mr. (now Sir Charles) Elliott in 1865 wrote — (f) Instances from replies to enquiry of Famine Commission as to exhaustion of soil i Central Province

"It stands to reason that land, even the black soil of the Nerbudda "Valley, must deteriorate if it is cropped year after year without anything "being returned to it . As long as half the first class was uncultivated, and a new field could be broken up for every one thrown into "fallow, the crops (of the Nerbudda Valley) are not likely to have deteriorated much But when once regular cultivation set in and the "majority of the land came under the plough, a certain amount of "deterioration followed

"The old rate of produce in the golden age, or fifty years ago, is supposed to have been tenfold, and judging from the Tapti Valley "I do not conceive it can have been more than twelvefold I reckon the "average now to be sixfold and my belief is that it fell very rapidly from "twelvefold to about eight, and then rather slowly to six or seven, that "it was at that stage when the land was reported 'very much exhausted' "in 1830 and that it has fallen very slightly, if at all, since then

Madras — ii Madras

"No Collector has reported that there has been deterioration of the soil "within his own experience, but some are satisfied, from the enquiries they "have made, that deterioration is going on The question of "deterioration does not specially arise in this Presidency with regard to "irrigated land On the contrary, visible deterioration is apparent "chiefly in connection with unirrigated land newly taken up, and not "unfrequently relinquished again after some years in favour of another "fresh field, or one that has had some years rest

51. The above extracts, while
proof that the process of exhaus
to much more than mere probabili
be accepted as an axiom in agricu
the land in crops must in some way be put back into the soil, or else the soil will suffer exhaustion. It is an equally accepted fact that the production of heavier crops means that more manure must be applied to the land A country which exports both crops and manure must be declining in fertility Now, what is the state of things as regards India? On the one hand there is a large export of oil-seeds, cotton, and other products, besides an increasing one of wheat, all of which remove a considerable amount of the soil-constituents What is returned in their place? Only the straw or the stalks and leaves, and it is not even correct to say that these are returned, for, after all, it is only a portion, and frequently a very small portion, that does find its way back to the soil. Part is necessarily used up in the bodies of the cattle, part is wasted by imperfect conserving and storing of manure, part must unavoidably be lost, however great the care that may be taken, thus it comes about that it is only a fraction that

contributes finally to making up the loss the soil has sustained

Were, on the contrary, all grain to be consumed by the people, and all night soil to be used in agriculture, were all refuse of oil seeds (after pressing out the oil) to be utilised for manure, were all straw to be consumed by cattle, and the droppings, solid and liquid together, to be carefully preserved, lastly, were all stalks and leaves to be buried again in the land, then the balance might be more nearly preserved But, as things are, the exports of oil seeds, grain, etc (that of bones I will discuss later), simply mean so much of the soil constituents *carried off*, for which no adequate recompense is made

The consequence must be that the soil becomes gradually poorer, though the effect may not as yet be visible to the eye, for, even if the soil be still producing the same crops, the *potential fertility* (by which I mean the reserve of constituents for the production of future crops) must be suffering loss, and the capabilities of the soil must be less than under a system of equal giving and taking In face, therefore, of the enormous increase recorded in the population, and future increases that will have to be met, it becomes a most serious question how the food for these millions is to be found, in other words, how the manure is to be obtained without which the crops necessary for feeding these people cannot be grown

The problem of the future

52 I cannot, therefore, agree with the theory that fixes a certain level to which production may sink, but below which it will not go This is apparent rather than real. The decline may be slow, but this is a mere matter of time When we compare the wheat-yields of different countries, we have, as nearly as one can judge, the following —

Wheat-yields of different countries

TABLE I —Wheat-yields of different Countries

—	India †	United‡ Kingdom	France.	Germany	Russia	Canada	United States of America.	Australia
	Bushels	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels.*
Average yield per acre in bushels*	10	28	17	18	9	14	12 5	11

* Taken from the Agricultural Returns of the Board of Agriculture 1890

† Average of the five years ending 1888 89 as given in the Government of India's statistics The average yield in 1889-90 was 9 4 bushels only

‡ Average of the last 40 years The average of the last eight years was 30 bushels

The wheat-yield in India will vary, not only according to the season, but also with the conditions under which the crop is grown for instance, it must be taken into account whether the land be manured or not, whether it be land dependent on rainfall alone, or supplied by irrigation as well, and whether rainfall be sufficient or not As nearly as a

conclusion can be formed, the following are the out-turns on some of the respective classes of land —

On unmanured dry crop land where rainfall is precarious and often insufficient - - - -	7 bushels per acre
On manured land in tracts of better rainfall - - - - -	10 " "
On manured and irrigated land -	15 to 25 bushels per acre.

In comparison with the above, it may be mentioned that in the Rothamsted Experiments the produce of land continuously unmanured for 40 years is 12¼ bushels per acre, at 61 lbs. per bushel

53 The real answer to the question whether the soil of India is becoming exhausted or not, seems to me to lie in the fact of the small produce annually removed In England, with its 28 to 30 bushels per acre, what is removed over and above the yield of the unmanured land is due to what is put into the land in the form of manure, India's 10 bushels, on the contrary, represent almost entirely what is taken out of the soil itself. The extra crop in England is, in other words, the produce of what is *added to*, and not, as in India, the produce of what is *taken out of*, the soil. Possible explanation of any decline in soil fertility not being apparent, though really existent

Nevertheless, the powerful sun of India, aided by moisture, or by water [illegible] I believe, a far more r[illegible]osing and bringing inte[illegible]nts of the lower layers of the soil and of the stones and rocks which go to produce soil than is the case in England, and why no decline is noticed, after a certain limit has been reached, may be due to there being just enough fresh material decomposed and brought into active condition annually to produce the requisite small yield It must not be forgotten, it is true, that the wheat crop of England is generally a nine months' crop, that of India only a five months' crop, but I believe that the influences named above are the most potent factors in causing the differences of yield Were demand, however, made upon the soil for a greater yield, the soil could no longer supply it, and it would have to be met by outside sources, in other words, by manure

Such a demand must be looked for in the rapidly increasing population, and in the greater difficulty of providing food for it. Sir James Caird, in treating of this problem, estimated that if the produce of the land could be increased by one or two bushels per acre the difficulty could be met It will be my endeavour to show in this and the following chapters that the necessary increase can only be met in one way, *viz*, by improving the *manure supply* of the country Improvement in the system of land tenure, improvement of the land by expenditure of public and private capital on it, and similar measures, may alleviate the condition of the Indian cultivator, but they will not give him larger crops, and they will not Importance of the question of manure supply

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Nevertheless, the powerful sun of India, aided by moisture, or by water (where it is applied artificially) exercises, I believe, a far more rapid and powerful influence in decomposing and bringing into an assimilable condition the constituents of the lower layers of the soil and of the stones and rocks which go to produce soil than is the case in England, and why no decline is noticed, after a certain limit has been reached, may be due to there being just enough fresh material decomposed and brought into active condition annually to produce the requisite small yield. It must not be forgotten, it is true, that the wheat crop of England is generally a nine months' crop, that of India only a five months' crop, but I believe that the influences named above are the most potent factors in causing the differences of yield Were demand, however, made upon the soil for a greater yield, the soil could no longer supply it, and it would have to be met by outside sources, in other words, by manure

Importance of the question of manure supply.

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provide the food that the people *must* have to live upon For this the *soil* itself must be looked to, as it alone can produce the crops, and *manure* alone can enable it to bring forth the necessary increment The question of manure supply is, accordingly, indissolubly bound up with the well-being and even the bare existence of the people of India.

Study of the constituents of the soil

54 Having considered the soil as a whole, and chiefly in regard to the important question of its deterioration or the reverse, it is well that I should now discuss the separate ingredients which go to make up soil, and which cause the difference between one soil and another The main ingredients are the following —water or moisture, vegetable matter or *humus*, sand, clay, and carbonate of lime These I shall take as presenting themselves in a chemical study of Indian as distinguished from English soils, and, in addition to pointing out the most characteristic differences, I shall endeavour to indicate possible lines of further enquiry.

1 Water or *moisture*

Special importance in India

55. First to be considered among the components of cultivated soil is Water or Moisture, without which no germination is possible In India the relation of soils to moisture acquires a greater significance than almost anywhere else, on account of the rainfall being limited to particular periods, instead of being distributed throughout the year, and because of the intense and prolonged heat, with consequent rapid evaporation Climatic conditions, as shown in Chapter IV, exercise most marked influences upon Indian Agriculture, and cause the practice of it to vary greatly in different parts.

Relation of soils *to moisture*

A striking difference is seen between the condition of English soils and that of the generality of Indian soils Speaking broadly, it may be said that the normal state of an English soil is "wet," and that of most Indian soils "dry," and whereas, in the case of the former, the object is generally to *get rid of* the superfluous water by means of drainage, the difficulty in India is as a rule, to *keep the moisture in* the land The relative behaviour of soils to the moisture which falls on them in the form of rain, or which is conveyed to them by artificial means of irrigation, is, therefore, of great importance The differences of geological types of soil mentioned in paragraph 45 must be here again borne in mind, and reference to the Geological Map will assist the explanation The alluvial soil (coloured brown on the map) which occurs in the Punjab and North-West Provinces, under conditions of a dry climate, low rainfall, and hot sun, soon loses its moisture and becomes baked, so that dependence has largely to be placed on irrigation, and the more so where the alluvium (or mixture of sand and clay) is sandy rather than clayey in character So, too, the hard rocky formation (coloured red) of Southern and South eastern India calls for the same measures But where, as in the Central and Western parts, the black cotton-soil (coloured green) occurs, we find a great difference, for this soil is naturally very retentive of

Alluvium

Hard rocky soil

Black cotton soil

moisture, and as it dries it cracks into blocks which, though hardened and baked externally, will be found, on being broken open, to have enclosed moisture within them, and to have thus prevented it from being lost So it comes about that there is always sufficient moisture for the germination of the seed, and for the growing of the crop Irrigation, consequently, is not necessary in these parts, and famine is of rare occurrence

Soil of tracts along river beds in the Punjab

There is another class of soil, that found in the tracts along the river beds of the large streams in the Punjab, which always has a sufficiency of moisture in it, although not actually inundated With this exception, and that of the black cotton-soil, it may be said that in the majority of cases great importance attaches to the retaining of moisture in the soil I have often been struck by the attention which the cultivator gives to this, and have noticed with surprise how, even under the influence of a burning sun, the land, by reason of the careful preparation given to it, is made to retain sufficient moisture to ensure the germination of the seed put into it, for, on turning up the earth to a depth of two, or at most three, inches, the precious water will be found in it In indigo-planting this is absolutely essential, and great is the care taken to break up and pulverise each crust that forms on the surface I cannot help suspecting that the system of shallow ploughing, as practised by the Native, and his aversion to ploughs that turn over a broad slice and form a wide furrow, may have something to do with this matter of the retention of moisture, and that the effect of deep ploughing would too generally be to lose the very moisture the cultivator so treasures

Importance in most cases of retention of moisture in soil

Shallow ploughing

Improvement of soil by increase of water supply to dry tracts

56 From the foregoing remarks it follows that one obvious direction in which improvement in soil can be effected, is the increasing of the supply of water to dry tracts, and thus of moisture to the land The means by which this may be done will be more specially treated in the next chapter, and it will suffice here to say that for any work to be carried out on a large scale it must be done by Government or by Government aid

This the work of Government

Harm occasioned by over-irrigation

57. While I have drawn attention to the importance of the retention of moisture in the majority of soils, it must nevertheless be remembered that this principle cannot be enforced everywhere, and that there are some instances of its misapplication, as in the making of canals where they were not really wanted Orissa is a case in point

There is little room for doubting that by the introduction of canals into tracts where there was no real necessity for them the soil has suffered from the removal of its valuable constituents through the continual washing process to which it is subjected, and also that a system of over cropping (beyond what the soil can bear) is frequently consequent upon the introduction of canals Other results attributed to canals are the spread of *reh* (see footnote p 37), the increase of fever through the raising of the water level of the country, and the destruc-

provide the food that the people *must* have to live upon. For this the *soil* itself must be looked to, as it alone can produce the crops, and *manure* alone can enable it to bring forth the necessary increment. The question of manure supply is, accordingly, indissolubly bound up with the well-being and even the bare existence of the people of India.

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Indian soils generally deficient in organic matter and nitrogen

A person with knowledge of agricultural chemistry will readily understand that such soils as the above can be considerably benefited by the application of cattle manure, by green-manuring, or by the use of other organic and nitrogen containing materials.

The importance of nitrogen is emphasised when it is explained that in the case of cereals the assimilation of starch is dependent [illegible] applied to the plant, and that it is [illegible] bring the different mineral con- [illegible] It is not enough to have mineral constituents present in the soil, but there must also be nitrogen in order to render them available for the plant's use

Functions of nitrogen.

It becomes necessary, therefore, to enquire very carefully into the sources from which nitrogen may be derived, and whether the deficiencies already noted may not be made up in some way or other

59 A considerable quantity of nitrogen in the form of ammonia and nitric acid is conveyed to the soil in rain The knowledge of the importance of nitrogen, and of its frequent deficiency in Indian soils, has led to an incorrect idea that the rainfall in India contains much more nitrogen than it does in England and other temperate climes, and that by this means the deficiency of nitrogen is met, and this important element is supplied to the crops This statement has been copied over and over again into books, and has been pointed to in support of another erroneous opinion, *viz*, that practically no loss is incurred by the burning of cattle manure so long as the ashes are used because the nitrogen that passes off in the burning is supposed to come down again in the rain I have paid special attention to examining the evidence on which these theories are based, and I have ascertained that the original analyses which gave rise to them were incorrect, in consequence of the impurity of the chemicals sent out from England Dr Van Geyzel, Chemical Examiner for Madras, has been kind enough to give me the information on this point, and also his own later analyses, from which it will be seen that the amount of nitrogen in the rainfall, as *now* returned, was, in 1888 only one thirteenth, and in 1889, only one-twenty fifth portion (4 per cent) of what was stated to be the amount in 1885-86 The following are the results, and by the side of them are given those of more recent analyses of

Erroneous idea that rainfall in India contains much more nitrogen than in England.

These various points will be dealt with in the next chapter It is necessary, however, to interpose here the caution that, while, in by far the greater number of instances the supply of water to and retention of moisture in the land is of the highest importance, it does not do to lay down a universal rule, and there are cases where any further supply of water would be attended by positive harm, or where measures for the *removal* of water might even be called for

2 and 3 Organ c matter and Nit ogen

58 The next soil-constituent to consider is that which is variably termed "Vegetable matter," "Organic matter," or "*Humus*." Al ng with it it will be convenient to take Nitrogen also, inasmuch as this constituent is, in measure at least, derived fiom *humus* Though apart from water, the carbonaceous constituents form the largest portion of ordinary crops, these are derived not from the soil but from the atmosphere, and therefore do not concern us so particularly here But the vegetable matter or *humus*, which has its origin in the dead roots and leaves of a previous vegetation, or in a previous manuring with organic materials, exercises a distinct influence on vegetation for, though probably not directly assimilable by crops, it is the principal nitrogenous ingredient of soils, and on being further oxidised will yield carbonic acid, ammonia, and, lastly, nitric acid This is effected by means of a nitrifying organism or *bacterium*, which occurs in fertile soils, and most abundantly in the surface soil The nitrates or salts of nitric acid thus produced are the form in which nitrogen can be taken up by plants as food

Hum its or g n and func tions

There are also *physical* advantages in the presence of vegetable matter in soils , such as, the binding together of sandy soil, the retention of moisture, the increase of porosity in clay soils Further, the presence of vegetable matter in the soil has an indirect influence on the climate, inasmuch as soils rich in it absorb more heat from the sun's rays than do light coloured, sandy soils, which are generally deficient in *humus*, and in consequence radiate out more heat

Organ c matter a d N ogen n Ind an so s.

On looking into analyses of Indian soils which have been recorded, and others which I have made myself, I find that, with the possible exception of black cotton soil, Indian soils are generally very deficient both in organic matter and in nitrogen *The following analyses will illustrate this* —

TABLE II —Organic Matter and Nitrogen in Indian Soils

—	1 Cawnpore Farm Soil (S A H l)	II Soil from Arrab Behar (E kin b)	III Soil f om S ipur Behar (E K nch)	IV Dumraon Fa m Soil Behar (E K nch)	V VI VII * Three S lls from Wheat growing Land in Sirsa D str t Punjab (J A Voel ker)		
Soil (dried at 212° F) conta ned —	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
O ganic ma ter and comb ned wa er	2·20	1 74	2 77	6 63	0 63	2 67	0 65
Nitrogen	0 3	0 5	0 3	0	07	0	trace

* For full ana yses *see* Append x A

In the foregoing analyses the organic matter is not stated alone, but along with it is the water which is chemically combined with the mineral constituents, and which is not removed at a temperature of 212° F. Accordingly, the organic matter appears more than it really is, but, when compared with ordinary fertile English soils, the quantities, with the exception of No IV, *read low*, and in some cases extremely so. In every instance the amount of nitrogen is small, and considerably below that found in the average of English agricultural land.

Indian soils generally deficient in organic matter and nitrogen.

A person with knowledge of agricultural chemistry will readily understand that such soils as the above can be considerably benefited by the application of cattle manure, by green-manuring, or by the use of other organic and nitrogen-containing *materials.*

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Humus its origin and functions

There are also *physical* advantages in the presence of vegetable matter in soils, such as, the binding together of sandy soil, the retention of moisture, the increase of porosity in clay soils Further, the presence of vegetable matter in the soil has an indirect influence on the climate, inasmuch as soils rich in it absorb more heat from the sun's rays than do light-coloured, sandy soils, which are generally deficient in *humus*, and in consequence radiate out more heat.

Organic matter and Nitrogen in Indian soils

On looking into analyses of Indian soils which have been recorded, and others which I have made myself, I find that, with the possible exception of black cotton-soil, Indian soils are generally very deficient both in organic matter and in nitrogen. *The following analyses will illustrate this:—*

TABLE II—Organic Matter and Nitrogen in Indian Soils

—	I Cawnpore Farm Soil (S A Hill)	II Soil from Arrah Behar (E Kinch)	III Soil from Sitpur Behar (E Kinch)	IV Dumraon Farm Soil, Behar (E Kinch)	V VI VII * Three Soils from Wheat-growing Land in Siran District, Punjab (J A Voelcker)		
Soil (dried at 212° F) contained —	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent.*
Organic matter and combined water	2·20	1 74	2·77	6 63	0 63	2 67	0 65
Nitrogen	028	0 5	0 3	05	07	·02	trace

* For full analyses *see* Appendix A

ous varieties of pulses, indigo, etc, are among the commonest crops, and are all highly nitrogenous, lastly, leguminous shrubs and weeds abound, and are often spread on the land or ploughed in as manure. How can this be in a soil naturally poor in nitrogen? The recent investigations referred to point to a strong probability that the conditions of India are peculiarly favourable to the fixation of atmospheric nitrogen through the medium of the nodules that are known to form on the roots of certain of the *Leguminosæ* at least. Support is given to this by the fact that quite lately, in Germany, Nobbe and Frank have found these nodules on the roots of leguminous shrubs, as well as in the case of the clovers and pulses that form our ordinary European leguminous crops.

A fertile field for investigation is herein set forth, and India, to my mind, presents special advantages for the elucidation of the problem, one which, when solved, will unfold much that is still unexplained in the advantages of rotation of crops. Field for enquiry.

61 The special case of black cotton soil and its properties has been mentioned, and this, again, offers a field of enquiry for its origin and its qualities are not fully understood. It is believed in some parts to be derived from basalt by surface decomposition, in others to be the impregnation of argillaceous earth with organic matter. Carbonate of lime is present to a considerable extent in black cotton-soil. In depth this soil varies greatly, at Akola it is from 40 to 60 feet deep, but further away it thins out to 19—20 feet, and after that gets quite shallow. In the rains it becomes quite impassable. It is generally supposed to require no manure and to be incapable of exhaustion. That it has peculiar powers, there is no question, but that it is so rich in vegetable matter and in nitrogenous ingredients as to be independent of manure, I do not think. I have not had the opportunity of studying it specially, but I give the following results from an analysis of black cotton-soil by the late Mr. S. A. Hill, and from one which I made of a specimen of this soil from Akola, in Berar. Organic matter and nitrogen in black cotton soil

TABLE IV.—Organic Matter and Nitrogen in Black Cotton-soil.

——	I Black Cotton-soil from North West Provinces, near the Jumna. (S. A. Hill.)	II Black Cotton soil from Akola, Berar. (J. A. Voelcker.)
Soil (dried at 212° F.) contained—	Per cent	Per cent
Organ c matter and combined water . . .	4·05	5·83
Nitrogen . . .	·086	·036

The amounts of nitrogen are very low, and though there is more organic matter than in the soils tabulated in paragraph 58, yet the quantities are not really large. Support is given

to my belief as to the condition of this soil, by the increasing practice, among the better cultivators, of manuring it. It was stated in Settlement Reports of the Nerbudda Valley some 25 years ago, that it was not the custom to use manure, but now in Saugor and Damoh it is by no means uncommon to find manure used, and the people all say that they want more

Sand and Clay 62 From the organic portion of the soil we may now pass to the principal inorganic or mineral ingredients, *viz.*, sand, clay, and carbonate of lime According as the sand or the clay (which is chemically, a silicate of alumina) predominate, so we find differences in the water-retaining powers of soils, for sand has the least, and clay the most, power of holding water This is well illustrated in the alluvial deposits brought down by rivers and streams, and which form the vast Indo-Gangetic plain These are composed of alternating layers of sand and clay, and as the transported materials, whether the heavier sand or the lighter clay, have been deposited on any spot to form there the surface soil, so may variations be found in the soil's water-holding capability. In parts, such as the sandy desert plains of the Western Punjab and Rajputana, the surface soil is principally sand, owing to its deposit there, while the finer and lighter clay has been carried on farther. Such soil, in the absence of water, is little more than desert land In other parts, clay may predominate and water be better retained* On the other hand, capillary attraction, or the force by which water is brought up from the subsoil to the surface during dry weather, is more active in clays than in coarse sands, and evaporation is more rapid from a consolidated surface than from an open and well-tilled one So it is that the incrustations of soda salts known as *reh* (*see* footnote, page 37) are found on the clayey rather than on the sandy lands Again, a sandy soil is a better conductor of heat than a clayey one, and, being thus more rapidly warmed or cooled than a clay, is not so likely as the latter to become "baked."

To show the variations that occur between soils even at no great distance apart, I give the following results from mechanical analyses by Professor Kinch, of Cirencester, of soils from Dumraon, Arrah, and Siripur, in Behar, sent to him by Mr *D. B Allen* —

TABLE V – Sand and Clay in Indian Soils

	I Dumraon Farm Soil	II Soil from Arrah	III Soil from Siripur
Soil (dried at 212° F) contained —	*Per cent*	*Per cent*	*Per cent*
Coarse sand	10.3	29.6	2.7
Fine sand	8.0	40.0	46.3
Clay etc	81.7	30.4	51.0

* The alluvial plains of India may be said to contain four types of soil (1) heavy loam of Bengal, where clay predominates (2) heavy loam with clay and some sand; this is found in the inundated land of Northern India and the soil remains in clods; (3) light loam of Behar and parts of the Punjab, where the clods fall to pieces; (4) very light loam and sand of some parts of the North West and the Punjab

63 The remaining principal ingredient of soil is carbonate of lime Reference has already been made to the peculiar concretionary form of limestone known as *kankar*, which occurs largely in India. These lumps are found near the surface and are, *doubtless, the result of the evaporation of water containing in* solution lime which has been obtained by the decomposition of the mineral portions of the soil. Now, lime works beneficially in many ways, it not only acts itself as a plant food but it makes clay land permeable to moisture, and enables it to absorb potash, ammonia, and other salts, whilst, not least of all, its presence is required in the process of nitrification, by which means nitrogenous matters in the soil are made available for the plant's use — 6 Carbonate of lime — *Kankar*

Speaking generally, lime is more plentifully distributed in Indian soils than in English, that is, deficiencies of it are not so frequently met with A notable exception, however, which I have found, is in the laterite soil of parts of Southern India, such as the coffee-growing districts of Coorg and Mysore, and the tea plantations in the Neilgherris, where, I have reason to believe, a more abundant supply of lime would be decidedly beneficial.

The following analyses exemplify these points — — Lime in Indian soils

TABLE VI —Lime in Indian Soils

	I	II	III *	IV *	V *	VI	VII	VIII †	IX †	X †
	Black Cotton soil near the Jumna, N W P (S A Hill)	Cawnpore Farm Soil (S A Hill)	Wheat soils from Persa Punjab (J A Voelcker)			Dumraon Farm Soil (E Kinch)	Soil from Arrah (F Kinch)	Coffee-soils from Manjerabad, Mysore (J A Voelcker)		
Soil (dried at 212° F) contained —	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Lime (calcium oxide CaO)	3 66	93	1·85	1 44	1 66	1·00	68	·20	·33	·32

The amounts of lime in Nos I—VII, inclusive are more than in most cultivated English soils, but in Nos VIII–X a marked difference is apparent Of the majority of Indian soils it may, however, be said that they contain a sufficiency of lime — Lime generally abundant.

64. Having taken now the principal ingredients of soils, we may pass on to those soil constituents which, while found in lesser amount, are, nevertheless, those which exercise a great influence on the productive power of soils Of these the principal are phosphoric acid potash, and soda, and they are the only ones that need be dwelt upon separately. Other — 7 a, e Iron, Alumina, and Magnesia.

* For full analyses see Appendix A

† For full analyses see Appendix B These soils had been cultivated for 50 years previously and only had bones in small quantity applied to them

constituents, such as *iron*, alumina, magnesia, etc , which are found in soils and which enter into the composition of plants, do not call for special *reference* Iron is a widely-distributed element in soils and occurs largely in the laterite soils of South western India, notably in the coffee soils of Coorg and Mysore This laterite is a porous, argillaceous rock, *impregnated* with iron peroxide (hydrated), *of* which it may contain 25 to 35 per cent Alumina enters into the composition *of* all clays but magnesia, so far as I know, acquires no special importance in Indian agriculture Magnesia appears to exist in sufficient abundance throughout, and more plentifully than in English soils

10 Phosphoric acid in Indian soils

65 Phosphoric acid I believe to be more abundantly distributed in Indian than in most English soils There are but few analyses to refer *to*, in consequence of the absence of *any* investigation in India from the standpoint of agricultural chemistry, but what analyses there *are* seem to show that *there* is, happily, not that pressing need for the additional use of phosphatic, and, I may add, for mineral manurial elements generally that there is in England. In the latter country, if a soil contained 0 12 or 0 13 parts of phosphoric acid *in* 100 parts of the dried *soil*, *this* would be reckoned a good average amount, and 0 17 per cent would be decidedly above the average From analyses of Indian soils I quote the following results, giving, for *convenience*, the determinations of potash in the respective soils at the same time —

TABLE VII —Phosphoric Acid and Potash in Indian Soils

	I *	II *	III *	IV	V	VI	VII	VIII †	IX †	X †
	Wheat soils from Sirsa, Punjab (J. A. Voelcker)			Cawnpore Farm Soil (J. A. Hill)	Dumraon Farm Soil (S. Kinch)	Soil from Arrah (S. Kinch)	Black Cotton soil from the Jumna, N. W. P. (J. A. Hill)	Coffee soils from Munjerabad, Mysore (J. A. Voelcker)		
Soil (dried at 212° F.) contained —	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Phosphoric acid	17	23	19	81	10	09	11	13	·15	10
Potash	·32	·74	·31	·33	1 58	60	29	15	·10	10

Although variations are shown in these results *as* regards the phosphoric *acid* present, in no case are there the marked deficiencies frequently met *with in* England, and, taking the four first named soils as representative of a *great tract* of wheat growing land, I should consider them especially well supplied with phosphates This may possibly have some

* For full analyses *see* Appendix A
† For full analyses *see* Appendix B

bearing on the question of the utilisation of bones in India as against their export. If a soil show no deficiency of phosphates, there may lie in this the explanation of the fact that bones have not as yet been clearly proved to be beneficial or necessary to a number of Indian soils

The utilisation of bones as manure

On the other hand, the somewhat lower amount of phosphoric acid found in the laterite soils of Mysore, together with the greater demands of the coffee plant upon the mineral ingredients of the soil, may be the reason that bones are in these parts used extensively by the planters, and are considered necessary. The benefit of their application may lie also in the fact that they supply lime and nitrogen as well as phosphoric acid

66. Potash, like phosphoric acid, is a very important plant food It appears to be well distributed, and its additional supply to be only exceptionally called for in Indian soils. For growing ordinary farm crops in England 0 25 per cent of potash in a soil would be reckoned a fair amount, but, as will be seen from the table given in the last paragraph, Indian soils may contain considerably more Only in the coffee-soils, Nos VIII—X, do we find what may be termed a deficiency.

11 Potash in Indian soils

In many parts of India, and notably in Behar, nitre (nitrate of potash) is found impregnating the earth, especially on spots where habitations have stood before. The earth is lixiviated with water and the nitre is extracted in an impure state, after which it is purified by boiling down the solution and crystallising out the nitre

Nitre

67. Soda, when potash is also present, can hardly be regarded as an essential constituent of plant life, and in India there is no lack of it. Indeed, the existence of soda salts in large quantity in the soil of some parts of India gives rise to an exceptional feature in the agriculture of the country. The selective power of plants for food is well known, and their preference for potash-containing rather than for soda-containing salts has been well established But in some parts of India, soda salts are present in the soil to such quantity as to positively destroy vegetation The salts are brought up from the subsoil by the combined action of water and the sun's heat, and then crystallise out on the surface, forming a kind of "snow" which is termed "*reh*,"* and the land thus affected is known as "*usar*"* land. The composition of *reh* is not uniform, most generally carbonate of soda is the prevailing ingredient, at other times sulphate of soda, but both occur together, and associated with them in more or less quantity are common salt and salts of magnesia and lime Of the origin of these salts there is no positive certainty, but they are most probably the salts which are dissolved out on the gradual decomposition of igneous rocks, and are subsequently deposited when the water which holds them in solution evaporates That they may be afterwards brought to the surface, depends on two conditions being present—

12 Soda in Indian soils

Reh and usar

* See [illegible] page 37

[illegible]

Improvement of soil by increase of manure supply.

62. [illegible] by manuring. The consideration of this subject, and of the means [illegible], will more appropriately [illegible] under Chapter VII ("Manure") than here. It is evident, however, that the increase of the manure supply for the purpose of enriching the soil is an important factor in the improvement of Indian Agriculture. To anticipate my conclusions, I would say that here again, as with the supply of water to dry tracts, the work will have to be initiated by Government, while, for the purpose of knowing what supplies are available, and what remedies can be effected, there is [illegible]ed of careful and scientific inquiry.

The work must be initiated by Government.

[illegible] by taking land into cultivation.

[illegible]. I pass on now to the second of the two heads given in [illegible]aph 48, under which agricultural improvement may take [illegible], the reclamation of land, or the rendering fit for cultivation [illegible]d which is now considered unculturable. Under this [illegible] reckoned ravine and similar waste land, land infested with [illegible]ass (*Saccharum spontaneum*) and other weeds, and, [illegible] or *usar* land.

Reclamation of ravine land.

[illegible] take place in two different [illegible] trees, shrubs, and grass, [illegible] bear crops. The considera[illegible] [illegible]ct will come more appro[illegible] when dealing with the [illegible] be incidentally remarked [illegible] question of w[illegible] trees and grass implies an improvement of the soil itself, in that the growth [illegible] becomes enriched by the accumulation of [illegible] *humus* derived from the decaying of the vegetable matter or [illegible]

leaves that fall upon its surface, as also from the herbage that grows on it, and which gradually dies down It is not often that land cut up by ravines can be levelled, and the whole area be thus turned into a culturable space, but much can be done to localise the effects of the floods that wash down and sweep before them the fine topsoil. In many cases these floods can be prevented from spreading their destructive influence further, and from injuring the lands that lie beyond them. The work of actually levelling ravines is too great and too expensive a one to contemplate, save in exceptional circumstances. Here and there an individual proprietor, having a large holding and also capital, may do it, and Government may also initiate it as a means of protection, or as "famine work," but it cannot be looked on as remunerative. Much, however, may be done by throwing embankments across the *nullahs* or channels made by ravine streams, and thus holding up the water and preventing the continual washing away of the surface soil. I give instances of what has been already done in this direction. Embankment of ravine streams

Captain Chapman, on his estate at Bâti, in Oudh, has carried out embankment of land on a large scale He has thrown masonry dams or *bunds* across 13 channels (*nullahs*) which had been cut by the rain water pouring down off the higher land and he now uses the reservoirs thus made by the collected water for irrigation purposes Captain Chapman has also reclaimed some of the ravine land by terracing it Captain Chapman's work at Bâti.

[illegible] experiment was begun in 1889 by [illegible] to see whether the denudations of [illegible] ed by making embankments which would hold up the rush of water in the rainy season and prevent it from washing the topsoil away It was thought that fertilising deposits of silt might be formed near the embankments, and that, as the water soaked into the ground, land might be left which would be readily culturable, while if the water did not disappear, it would serve for irrigation use The soil is thin, with rock underlying it, and wells are very difficult to construct There is evidence that in former days, when the country around was richer, the Natives used to throw up similar embankments, and that the large proprietors used to construct dams to hold up the water, but these have now been let fall into disrepair. Mr Ward in 1883 began to throw up a series of embankments or *bunds* of earth, and at present 30 such have been made, the slopes have been sown with babul (*Acacia arabica*) and grass is covering the sides. As yet [illegible] water has collected to be used for [illegible] ltivated, but the trees have grown [illegible] g, *dub* grass (*Cynodon Dactylon*) [illegible] said that the Station of Jhansi is [illegible] Experiments at Jhansi

At Nawabganj, near Cawnpore, I saw 220 *bighas* of land (1 *bigha* = [illegible] acre), which six years ago, was waste ravine land under the Court of Wards An enterprising Native became proprietor of this area, levelled it, and then let it out to cultivators It is now rented at Rs 5 per acre Reclamation at Cawnpore.

Again, at Etawah (N.-W. P.), although the ravine land there is converted into a "Fuel and Fodder Reserve," yet, where the ravines lead down to the river (the Jumna), cultivation is carried out on every bit of land that offers itself, and crops are grown partly on the soil washed down from the higher ground, partly on the silt washed up by the river If in such Reclamation at Etawah

places the first rush of water th … e stopped
by embankments, then the g … of being
washed away into the river, a … ilable for
cultivation, but the water mig … Ravines
such as those at Etawah exte … umna and
Ganges rivers

Reclamation of other waste land

71 There may be other waste land besides *usar* and ravine land which is capable of reclamation

Lake land at Bati

I saw with great interest at Bati (Oudh) the 7 000 *bighas* (*bigha* = ⅝ acre) of land which Captain Chapman had, with extraordinary energy, reclaimed Formerly it was one vast lake into which the Ganges, when in flood poured each year What Captain Chapman did was, to shut out the Ganges entirely by constructing a massive embankment or *bund* 7 miles long, and he then proceeded to pump the water back into the river This work begun in 1873 4 is now nearly complete, and what before was a lake is now culturable land thrown into the property With the help of steam ploughs and pumping engines the land has been tilled, drained, and also irrigated, and the soil, being naturally very rich, can grow splendid crops without any manure

Reclamation of land from the sea

'Choh' land in the Punjab

… and near the sea has been
… the Punjab, notably near
… of reclamation Streams
… silt but sooner or later
… e good soil from villages
higher up is washed down, but soon the sand comes, and this is driven about with the wind, and the good soil is covered and rendered unculturable The land thus destroyed is called "choh" land Some 30,000 acres of good land have been spoilt in this way, and remedies have in vain been suggested The cause assigned is that the hill sides have been over-grazed, and the trees along the banks of the former streams have been cut away, so that the soil is not held up and the streams, no longer confined to their course, have spread over the country The apparently most reasonable suggestion made is to close the hill wastes to grazing, and to let the sides clothe themselves again with grass shrubs, and trees There are, however, difficulties in the way of dealing with the "chohs" under Chapter III of the Indian Forest Act, the Government not caring to risk the responsibility of having to acquire the land (as they might be called on to do) some 10 or 12 years hence at fabulous prices

Land infested with *kans* grass and *kunda*

72. The infestation of land with *kans* grass (*Saccharum spontaneum*), with *kunda* (*Saccharum ciliare*), and other deep-rooted and fast-spreading weeds, is a matter for which there are remedies in deep and continuous cultivation and stirring of the soil, also by heavy manuring, and by leaving the weeds to rot, as well as by embanking and flooding the land with water But, unless these steps be taken in hand early, the evil may rapidly increase, and the land be pronounced unculturable. Mr. Gollan, the Superintendent of the Saharanpur Botanical Gardens, pointed out to me the grass in the Municipal Gardens, Saharanpur, it is now a mass of *dúb* grass (*Cynodon Dactylon*), but had at first been infested with *kans* By manuring the land heavily with night-soil and town refuse the *kans* grass had disappeared entirely Mr. Gollan believes that this can be effected in a single season, and he instanced to me that the same thing had been done at Wingfield Park, Lucknow.

I have myself seen, in the Central Provinces, land that was within quite recent times under cultivation, but which has

been abandoned on account of the *kans* grass I learnt that the rent had been remitted on this account, but I could not help thinking that had the *raiyats* been obliged to cultivate their fields diligently, as they would have been, for example, in the congested districts of the North-West Provinces, the *kans* grass would soon have been eradicated A North-West *raiyat* would have quickly been down on hands and knees and never have let the weed get the mastery Here, on the contrary, amid easier surroundings, not only was the cultivation less careful, but as each field was in turn abandoned the weed spread, and its seed was carried on to the neighbouring plots, while the tenant who should have eradicated it at the beginning, rejoiced in the remittance of his rent It may seem a hard thing to say, but I fully think that, in cases such as this, the improvement of the soil will be mainly effected by the pressure of circumstances necessitating a better and more careful cultivation

In the Madras Presidency I saw a quantity of land near Bellary infested with the weed *kunda* (*Saccharum ciliare*), as also near Gadag, and along the Kistna river. The cultivators dig up the weed by hand labour, collect it in heaps and burn it.

73 Of a different nature to the foregoing is the improvement of saline land or *usar*, a subject on which much good work energy, and ability have been expended by the Government, and mainly by the Agricultural and the Irrigation Departments of the North-West Provinces *Reclamation of saline land (usar)*

Usar land, as explained in paragraph 67, is land which is impregnated with soda salts to such an extent as to make it unfit for growing crops A white "snow," which is made up of these soda salts and is termed *reh*, spreads over the surface of the ground and cultivation is impossible Enormous areas, especially in the plains of Northern India are thus affected, and in the North-West Provinces alone there are between four and five thousand square miles of *usar* land In the Deccan and in the Southern Mahratta country, too, are similar large tracts. A strange feature is, that, scattered amidst the barren parts are patches here and there where cultivation, and that, too, of a high order, is carried on Such crops as opium, sugar cane, wheat, castor oil plant, and cotton, all of which require a good soil and high cultivation, may be seen on these fertile spots, standing out like oases in the salt-covered desert all around them. How this has come about, whence the salts are derived, whether they are spreading in extent or not, how they may be checked, and how the land may be reclaimed, are questions which have led to many long enquiries and experiments to which I must here refer Already in 1874 the Irrigation Department of the North-West Provinces set about trying to reclaim *usar*, and in 1877 a "Reh" Committee was appointed to investigate the subject, and to determine the lines of future enquiry Subsequently, experiments were commenced at Awa in 1879, at Cawnpore in 1882, and at Aligarh in 1885 Most of these being still in progress, I was enabled to visit them and see what had been done

Extent of usar plains in the N W P

The "Reh" Committee 1877.

The origin of *reh*

74 Naturally, the first question for the "Reh" Committee was, to say what *reh* was, and whence it came Its composition, as explained in paragraph 67, is variable, but soda salts are always the main ingredients, the carbonate of soda preponderating generally, at other times the sulphate of soda, common salt and salts of magnesia and lime occur likewise What accounts for the preponderance of one salt or the other on any particular area has not yet been shown. Different views have been propounded as to how the soda salts originated.

Professor Medlicott's views

Professor Medlicott, who was a member of the "Reh" Committee, held that *reh* was the result of the decomposition, by air and water, of rock minerals found in the soil, and that they were those parts unassimilated by vegetation, and which were not removed by rain water He was, further, of opinion that the upper layers of the soil were originally quite free from salt, but that consequent upon the destruction of forests and the extreme climatic conditions that followed, aided by the introduction of canal irrigation, the salt was first dissolved and then brought to the surface Professor Medlicott, relying upon one or two analyses made at his instigation, regarded the canals themselves as bringing a considerable amount of salt, and expressed himself strongly to the effect that where canal irrigation came, there must, in a few generations, be complete destruction by *reh*. In his view, *reh*, accordingly, was saline subsoil water

Sir Edward Buck's views

Other opinions found expression in the "Reh" Committee, Sir Edward Buck attributing the appearance of *reh* to the presence of a series of depressions, the salt from the higher parts getting washed into the depressions by the first shower of rain, thus the higher portions might become culturable, and the depressions infertile, owing to the *reh*

Opinions of the Reh Committee

Finally, the Committee came to the general conclusions that *reh* was the result of evaporation in a dry climate, that it would make its appearance if the water level were raised, that it spread to a limited extent by surface washing, that its occurrence was concurrent with that of an impermeable surface, and that canal water did not itself bring the salt to the land

Review of the evidence; my own conclusions

Reviewing the facts brought out, it appears to me that there *is not sufficient evidence for believing that the canal water* actually brings the salt to the land The analytical evidence on which the assertion is based is neither strong nor consistent, the amount of solid residue per gallon in some of the analyses of water quoted is about 28 grains, a by no means large amount, while in others it is given as only 11 or 12 grains per gallon Analyses made by myself of canal water from the Cawnpore branch of the Ganges Canal gave only 15 grains per gallon of solid residue, containing less than 2½ grains of soda salts, while that of water from an adjoining well showed 72 grains per gallon of solid residue and 40 grains of soda salts One would expect the well water to cause an efflorescence of soda salts rather than the canal water, but this was not the case

Again, if canal water were the real source, it would not, to my mind, explain the fact that the composition of *reh* varies so much,

occur here and there, with culturable patches between I am much

similar mineral deposit is formed, or as a bed of sand, of gravel, or of clay, is found So long as the surface was covered with trees and vegetation there would be less capillary attraction, but with the denudation that ensued would come the "baking" of the surface, where this surface was clay, capillary action would be much increased Without moisture, however, the salts might remain harmlessly below but if we now imagine canal irrigation to be introduced, there would be present the two forces requisite to bring the *reh* to the surface, *viz*, the water to dissolve the salt, e, such as the sun, to beat down and to draw the salt-holding by the capillarity of the clay account for what has been often observed, *viz*, that *reh* occurs in impermeable clay soils, and but very seldom on sandy soils I incline, therefore, to the belief that where, amidst *usar*, culturable spots are found, it is either because these are spots where there is no *reh* underlying, or because, on account of the occurrence of a sandy rather than a clayey topsoil, capillary action is not so strong at that particular place The same result of reducing capillarity would be effected by cultivation, by manuring, or by the growth of trees, shrubs or grass The fact that such measures as the above have proved the best in the endeavour to reclaim *usar* land gives considerable reason for believing that their removal has conduced to its existence

The variableness, not alone of composition, but of the *extent* of the action of *reh*, is another reason for considering its occurrence as *local*, and not as coincident with the distribution of canal water There is what is called "very bad" *usar*, there is also other which, though salty, may be fairly easily reclaimed, and these are *often found in close proximity to one another* *How could this* be unless the deposits were *local*, *i e*, unless there were more salt in some spots than in others? Nor would it be consistent altogether with a theory that attributes its occurrence solely to the incoming of the canal water Canal water, I have no doubt, supplies one factor necessary to bring *reh* from below to the surface, but I do not at all think that it directly brings the *reh*

75 Passing next to the experiments made for the purpose of reclaiming *usar*, I must briefly note these — Experiments for reclamation of *usar*

The Irrigation Department of the N -W P began in 1874 by taking up areas in the Aligarh and in the Etawah districts At Aligarh there are now three areas treated as plantations. The best result was attained by digging holes, 4 feet deep filling them with canal silt and then planting *babul* trees, — Experiments of Irrigation De-

At Etawah there are also three areas, and here the most successful plan has been to embank land and to run canal water and silt over it for about four months These areas may now be described as reclaimed, as they have been let out for cultivation Still, it is held that the capitalised value of the improved land has not covered the expenditure.

Experiments of Agricultural Department N W P

1 At Awa

In 1879 experiments were begun at Awa by the Agricultural Department of the N.-W P Here tree planting was not tried, but only simple enclosure and exclusion of grazing Although the experiments came to a premature end, owing to the Awa Estate falling out of Government hands, they

2 At Juhi

mostly covered with reh ... it seems, however, doubtful if a fair interest on the capital expended will be yielded

3 At Amramau

embanked fields before the rains came, and so held up the water in them, when it had soaked in, he ploughed and manured the land with the dung of his cattle and sheep, and then sowed rice If the rice took a winter crop ... one half of the ... The total cost of ... the Director of ... ture is that land lords (*zemindars*) around are beginning to try the experiment themselves Immense credit is due to Mir Muhammad Husain for the way in which he devised and also carried out this experiment, certainly the most hopeful of any yet attempted in the reclamation of *usar*

4 At Aligarh

At Chherat there are 212 acres One-half is left to itself, like Juhi, and

none outside On these hills were gathered the glumes of the grasses, doubtless adding more vegetable matter to the soil as well as loosening it On comparison of notes that had been taken, these ant-hills were found to have moved

over the surface, or be run into catchment holes or channels it would do no further harm However this may be, I believe that it is from these raised

the rising of a small mound or embankment On one part of Chherat the ex-

and to cover the surface, oots would be at once nibbled and *dab*, also in turn appeared Yet another portion has been flooded from the canal, and the water held up by embankment, reclamation has gone so far that some of the

it here f more (doubt- n asked ed and nt was

Another plan of reclamation tried has been that of manuring heavily with night-soil.

At Narainpur, near Cawnpore, Mir Muhammad Husain took up 10 acres of *usar* land four years ago, and trenched night soil in it before the rains. Mounds were put round, and the rain water held up After ten months the land was let to a cultivator for Rs 20, and Rs 40 was offered if a lease for six years were granted Here canal water was available Of this land there were 800 acres in the neighbourhood 5 At Narainpur by use of night soil

6 At Dera Ismail Khan with night soil

Lastly, I have to instance other attempts to deal with *usar* land by growing trees upon it In the cases given so far the success has not been a marked one, though it has been shown that they will grow, as also grass in abundance, if enclosure be resorted to

7 At Kapurthala by growing *dhák* trees

In the Kapurthala State there are 9 000 acres of land in Phagwara *tahsil* which have been taken up by the Administration Of this 7 660 acres are so

[illegible] le the yearly [illegible] with *dhák* [illegible] o injury I [illegible] eriments, it should, I think, be more extensively grown on *usar* land and there seems to be no reason why the Kapurthala plan should not succeed elsewhere

Summary of experimental work on *usar* reclamation and general conclusions

76 To summarise the experimental work done on the reclamation of *usar* It seems thoroughly established, Firstly, that by simple enclosure and exclusion of grazing, grass (probably *usar* grass only at first) will establish itself, and cover even the worst places, that the grasses will slowly improve, and trees may be fairly successful Secondly, that by covering *usar* land with a thick coating of canal silt, and then flooding it (as is done in Egypt), it may also be reclaimed Thirdly, that by enclosure, feeding off the grass, embanking the land, allowing the rain water to be held up on it, then ploughing and manuring it, it can be rendered culturable Fourthly, that the same may be done by heavy manuring with night soil, where water is procurable There are difficulties to be encountered in every case, such as that of disposing of the grass grown, then canal water and canal silt are not everywhere available, nor is there sufficient night soil or other manure to warrant the outlay involved in reclaiming But it seems to me that the plan of embankment and holding the water up, as well as manuring the land with stock put on it, is feasible everywhere Where silt laden canals are at hand, they could be run on to the land, for they would be in a silt laden condition just at the time of the rains, when they are not so much needed for the irrigation of cultivated land As to the grass difficulty, this might be overcome by making the grass into silage. The difficulty with hay making is that the grasses that grow often come during the rainy season, when they cannot always be made into hay, but if made into silage, simply stored in pits dug in the ground, they might afford abundant succulent fodder for cattle Lastly, where trees are grown, the best plan is to have a rapid succession of quickly growing trees or scrub, rather than to try and obtain trees of any good size, the *dhák* (*Butea frondosa*), as at Kapurthala, should also be much more extensively tried

Suggestions have been made in the past that subsoil drain-

age will be found the only way to cure *usar*, but I can hardly look upon this as a practicable remedy in India.

Taking what I have seen, both of the occurrence of *usar* land and the attempts made to reclaim it, I believe it to be concurrent with the existence of an impermeable condition of the soil, conducing (as clay does) to increased capillary action, and that improvement of such soil will be effected by any means which tend to alter this impermeable condition, either by forming a fresh and lighter surface, such as is done by the finely-divided canal silt, or by breaking it up, as is done by the growth of grass or trees, or by manuring and ploughing The formation of vegetable matter on the surface is, I believe, most important, and the covering of the soil with grass tends to decrease that "baking" of it which, as we have seen, is one of the most powerful agencies at work in causing *reh* to appear

A good deal has been said, notably by Mr. Holderness, the Director of Agriculture for the North-West Provinces and Oudh, as to the result of the experiments not having been a financial success on the whole. To my mind a great deal too much has been made of this aspect, not that it is not the ultimate test of success, but because it should be remembered that until the effort has emerged from the experimental stage it cannot be fairly put upon its trial So long as experiments are being tried, expenditure is made upon a great many things which have to be abandoned later on, experiment should be for the purpose of seeing *which one* of a number of different plans that have suggested themselves seems to give the *best prospect* of success, but not until this has been reached can the system itself be fairly said to be on its trial. It is a remarkably promising omen that Mr. Husain has been able to show, even in the initial stage, such success as has been attained at Amramau, and to him very great credit is due.

Not long ago it would have been said the *usar* could not be reclaimed at all, and to show that it can be is, in itself, a most valuable fact That it may not at present *pay* to take up *usar* land and so reclaim it, is a matter affected by present conditions, but there may come, ere long, a demand on the soil, owing to pressure of population and spread of cultivation, which may call for even *usar* land to be taken up, and then it may pay well to reclaim it The experience gathered from past experiments will then supply the necessary guide, and a financial success may well result

77. The reclamation of land, whether it be ravine land or *usar* land, must, as indicated in the foregoing pages, come mainly from Government agency. In a few instances the Native proprietors may follow an example set, but the initiative must come from Government, and from Agricultural Departments in particular The improvement of land infested with *kans* grass and other weeds is part of a better and more careful cultivation. Reclamation of waste land must be mainly the work of Government

78 In reference to the reclamation of *usar* I have expressed my surprise at this enquiry having been carried out without the The need for an Agricultural Chemist

help of an Agricultural Chemist Such a man would have been able to render y mistakes and e instance—wher tainly have been ascertained (as could have been done readily by chemical analysis) what amount of salt was present originally in the soil, and how much salt each remedial process had succeeded, in the end, in removing It is still unknown in what quantity the salt exists, and in what amount it will be injurious Such an example as this constitutes a strong claim for having agricultural investigation in India carried out with the association of an Agricultural Chemist. I do not say that the presence of such a man would, of itself, enable the *reh* question to be solved, but I am sure it would very greatly aid the enquiry, and no such enquiry should be carried out without the assistance of an Agricultural Chemist.

CONCLUSIONS

CONCLUSIONS

79. The differences which are directly traceable to the varying nature of soil are, like those resulting from climate, not capable of elimination either by the people or by the Government, they can only be modified to a certain extent Any improvement of agriculture in this connection will be achieved by—

(1) increasing, in dry tracts, the supply of water and, consequently, of moisture to the soil,

(2) increasing the manure supply and enriching the poorer soil,

(3) experimental enquiry and the scientific study of soils and their treatment

The main work of the above must fall upon Government, for the people will only in a few cases, at best, follow the initiative set, nor indeed will they have the means for so doing. The third part, or the introduction of Western Science, must also come from Government alone. Of scientific study of soils in India there has been almost a total absence in the past, and experimental work, as in the reclamation of *usar*, has suffered in consequence. I regard the problem of the possible exhaustion of the soil, under a continuation of the present system of agriculture, as one which the Government will have to meet by devising measures for increasing the manure supply of the country Good work has been done by the Agricultural and Irrigation Departments of the North-West Provinces in the endeavour to utilise ravine land and to reclaim *usar* land, and encouragement should be given to the continuance of this work of enquiry.

RECOMMENDATIONS

RECOMMENDATIONS.

80. I recommend —

The increase, by means of Irrigation, of the water supply to dry tracts.

The increase of the manure supply to the soil

The instituting of Enquiry to ascertain where such measures are needed and can be carried out

The continuation of Experimental Research, aided by Chemical Science.

CHAPTER VI

WATER

81. WATER, in one for ture, and in no country cance than in India So tions met with in different parts, that each must be considered by itself before any general conclusion can be arrived at as to the sufficiency of the rainfall or the need of supplementing it Not only climatic but geological features also will determine the need and the mode of of the natural rainfall m sense we may consider —

General division of India in reference to irrigation requirements

1st Where irrigation is *not needed*

2nd Where irrigation is *highly desirable.*

3rd Where irrigation is *absolutely necessary*

Division into protected and precarious tracts

82 The *first* division comprises districts where there is an abundant rainfall, these are protected thereby from drought and famine, such regions exist over Burmah, Assam, Eastern Bengal, along the sub-Himalayan range, and in the Western Ghats In the Central Provinces also, and over a great part of Central India, a sufficiency of rainfall is aided by the presence of a black soil which retains that water firmly, and to which the supply of irrigation would possibly be even harmful

The *third* division comprises the driest tracts of all the regions of lowest rainfall, such as the arid plains of parts of the Punjab and Rajputana, with nearly the whole of Sind In these, while irrigation is an absolute necessity for the carrying on of agriculture yet in respect of being subject to famine they are safer than those of the *second* division, this latter including all those districts where the rainfall is uncertain and variable The reason of this, as explained in Chapter IV, paragraph 34, is, that where rainfall is low the *raiyat* or cultivator will never try to grow a crop unless he has a certainty of water, whereas, in parts to which sometimes rain comes in sufficiency and sometimes not, he is tempted to risk the growing of a crop, and should the rain then fail, the crop may be entirely lost It is these districts of uncertain rainfall that are the really "precarious" ones, and here the fear of famine is almost ever present They are the tracts which are

Precarious Districts indicated on Rain fall Map

...y extend over a great Deccan, and Madras ne in these precarious tracts that Government have devoted such constant efforts, and that so much skill has been exercised by the Irrigation Department in particular

83 It is well now to summarise the main types of water supply met with in India and, after that to show how irrigation alters in character and how its extension is largely dependent upon the physical conditions and geological features of the country

Summary of main types of water supply and their distribution

(a) In the first place is the *Rainfall*, abundant reference has been already made to this in Chapter IV (Climate) The *dark coloured* parts on the Rainfall Map are those of heavy rain, and are thus naturally protected from drought Under the same heading has been mentioned the water retaining black cotton soil, where, too, irrigation *is not called for This soil covers the parts* coloured *green* on the Geological Map

(a) Rainfall

The above districts may be considered as "protected," and as not requiring further irrigation

(b) After this we may take those districts which do not require irrigation, because they are *inundated* by rivers, or which, though not inundated, yet derive sufficient moisture from rivers in their proximity Instances of the latter have been given in the tracts along river beds in the Punjab Inundated tracts are found also in many parts of the Punjab, for instance, at Multan, where the country beside the river banks is often flooded to the extent of six or eight miles Again, in [illegible]

(b) Inundation by rivers and streams

level is too deep for irrigation wells so the flood waters of the torrents that issue from the hills are turned out of the beds of the torrents by means of temporary dams erected in the beds, and are thus poured on to the slope of the country The latter thus acquires sufficient moisture and also a renewal of silt more than equivalent to a manuring An instance of a dry tract such as this is Shahpur, between the Indus and the Jhelum

(c) Next are the canals —

(c) Canals and river-channels.

These may be classed under three heads —(1) The *perennial canals from snow-fed rivers,* found, for instance, in Northern India (2) *Inundation canals,* available only while the river is in flood The banks of the river are above the level of the surrounding country and the flood waters are carried off from the river This is, accordingly a rainy season supply only Such canals are met with in the Southern Punjab and in Sind (3) *Canals* or other *channels from rivers that are not snow fed* A dam, or "anicut" as it is technically known, is thrown across the bed of a river, and the latter is turned into a lake, from which it is led into irrigating canals and distributing channels In this way an

5

autumn and winter supply is obtained. Of this nature are the channels off the Cauveri, the Godaveri, and the Kistna rivers, in Madras.

(d) Wells

(d) The next system is that of wells, the most widely-distributed one, but seen principally in the alluvial belt of the Ganges plain, and notably in the Doab (or *two-river* district, i.e., the country lying between the two rivers, the Ganges and the Jumna).

(e) "Tanks"

(e) Then follow the so called "*Tanks,*" principally found in Madras, where the ground is rocky and the country hilly or undulating. These are really lakes or reservoirs, and are constructed by putting dams across depressions or valleys. In them rain water is collected for use in the dry season. Some are also fed by jungle streams and rivers as well as by rain water. They occur, further, in *Rájputana and in Central India.*

(f) Shallow tanks or ponds

(f) Lastly come the *shallow tanks or ponds* which are dug in the earth whenever the soil is of a clayey character, and serve to hold the one year's supply of rain water. These ponds are met with in Western Bengal, the valley of the Ganges, as also in Madras.

Distribution of systems of irri[illegible]

84. On referring to the Geological Map, sufficient reason will [illegible] systems in each part, [illegible] the map) lending it- [illegible] and the rocky ground [illegible] o-called "tanks," as [illegible] k cotton-soil portion (the part coloured *green*) needs neither particularly. But the variations of rainfall, situation, and nature of soil, in different parts call for still further consideration. Thus, to take the alluvial plain of the Ganges—in the extreme west the water lies too deep down for wells, and this part, including the Punjab generally, is essentially the region for *canals*, the central part, the North-West Provinces, is the *well* district *par excellence,* though supplemented here and there by canals, then, coming to Bengal,—in the western portion are *shallow ponds* or tanks, and mainly where clay covering the soil enables the water to be retained, whilst in the eastern portion the rainfall itself is enough, and canals would be out of place and even do harm. In Madras the underlying rock, [illegible]

Provinces, a cross section may be drawn through the Gangetic plain, and it will exhibit different features of irrigation in each division. Thus, taking such a cross section, we may have, first of all, a region [illegible] where rainfall is abund- [illegible] e will come one [illegible] elow the surface, [illegible] say, 10—20 feet depth. This is the case, for instance, at Bareilly. Next may be

one where the water lies deeper and is less readily obtainable, and canals may be called for in addition Such is found to be the case in the Doab, where wells are 20—30 feet deep Lastly, may come a region situated on a central elevated ridge of the country where the wells are too deep to be profitably worked, the water is often brackish, and canals are the only available means of irrigation This is the case along the Jumna river, the wells being 30 feet deep or more, and the water bad

I have set these points out, because without bearing them in mind it is not possible to understand the considerations that have to be taken into account in providing for the irrigation of any tract, nor yet to grasp the point of what I wish particularly to impress, *viz*, the necessity of careful enquiry into the agricultural requirements of each separate district and the best way of supplying these.

85· Before dealing with particular points connected with each class of irrigation, in the endeavour to show where improvement may possibly be effected, I wish to qualify any suggestion I may make, by saying, at the outset, that I consider the way in which Government have attacked the problem of irrigation and the manner in which t ork, are worthy of of each to meet, try, both for protective purposes and for the improvement of its agriculture, shows how deeply concerned they are in the well-being of the people

The great work done by the Government and the Irrigation Department

Easy though it be to criticise Government Departments, be they mistakes e harm right, fit that tention Irrigation It is hardly necessary even to ask that the operations should be extended, for both Government and the Irrigation Department are fully alive to the necessities, and will not fail to avail themselves of every opportunity for extension of their work.

86 *Perennial Canals* —It has been explained that in certain parts, for instance, the Western Punjab, the rainfall is very meagre, and the water level is so low that wells cannot be sunk profitably, hence the canals from snow-fed rivers are the only means of irrigation I cannot give a better instance of the change effected by the introduction of a canal to a dry, arid tract, than what I saw in the course of my tour through the country lying around Multan in the Punjab The Sidhnai Canal has been brought here, and now, wherever it spreads its arms, fertility and prosperity abound, whilst the parts which lie beyond its influence are typical of barrenness and desert Here a complete transformation in the appearance of the country has been effected The soil, though in itself rich enough, is powerless, in the absence of water, to sustain its crops It is only where an occasional well

Perennial Canals

Changes produced in the appearance of the country by the introduction of a canal into a district.

occurs, or where water has lodged in a depression, that there is any cultivation at all, but where the water can reach, agriculture flourishes. On one side of the railway line, as I travelled from Multan to Rashida, the Sidhnai Canal spread, and cultivation was all around, on the other side of the line there was no canal, and the land was entirely bare, save for a few stunted bushes. No one could see the contrast presented, without being deeply impressed by the great good done by canal irrigation. This scheme was started in order to take settlers from the congested districts of the Punjab (Lahore, Amritsar, etc.). It was estimated that 64,000 acres of land would be required, but already 110,000 acres have been let to cultivators, so that the canal has been very successful. Other instances which particularly struck my attention, as exemplifying the beneficial effects of canals upon agriculture, were the remarkable development of market-gardening around Amritsar (Punjab), the outcome of the Bari Doab canal, the sugar-cane and rice cultivation at Hospet (Madras), which has entirely developed since a channel was taken off from the River Tungabadra, and the sugar-cane cultivation around Poona.

Beneficial effects of canals (The Sidhnai Canal.)

When speaking of wells I shall have occasion to point out respects in which I consider that cultivation by means of them is superior to cultivation by canal, but it is necessary to point out that it is only in a very limited region, mainly the Doab, that the two systems really come into competition. What is requisite in extending canals is, to take them primarily to those districts which have no other available means of water supply, but not to supplant an existing cultivation carried on by means of wells or tanks. But where these latter means are insufficient, then canals may do a great work in supplementing the supply. The main object should, however, be to carry canals to the parts where agriculture must depend upon them alone.

Primary use of canals

Objections urged against canals

87. It has been urged against canals, and with some reason, that in some cases they have been brought where they were never needed, that they have been carried across the main drainage lines of the country, and have obstructed the natural drainage, besides raising the water-level, causing the spread of the saline efflorescence known as *reh*, spoiling the wells, and bringing fever and ill-health to the population affected. There have been, and always will be, minor complaints of the occasional harshness of higher, and the corruption of inferior, canal officers. But, to my mind, all these objections sink into insignificance be- [illegible]

tion and of distribution—but they are now careful to avoid these as far as possible, and when extension of canals is made, it is only after the agricultural circumstances and needs of the districts have been considered, in order to determine whether they ought

to be served by canals or by wells, and in order to construct the canals so as to give distribution of water over the widest area possible

88. *I will now consider the several objections taken to canals.* The first is, that canals have been carried where there was no need of them. A colour is given to this objection because, in order to reach tracts where there is no other means of water supply, canals have sometimes to pass through districts already provided for; still, it is quite true that canals have been brought unnecessarily to some parts of the country. In the Cawnpore district of the North-West Provinces there are many villages along the line of the canal, like Rura, which ought to have depended upon wells, and, indeed, were partly supplied with them; but now only the ruined *Canals have been taken where not required*

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destruction of wells undoubtedly occurred at first, yet the water-level soon became constant, and wells can now be easily made without masonry. What really happened was, that when the canal came the cultivators relied entirely on it as the easiest means of watering their fields, and so they used the water wastefully, and allowed the wells to fall into disrepair It is only when the supply of water runs short, owing to the spread of irrigation over a wider area, that the *raiyat* begins to get economical in the use of canal water. In some instances, indeed, the canals have improved the wells by raising the water-level and making the supply more accessible Still, there is undoubtedly some reason for complaint that canals have been carried where they were not required. An instance of this is seen in Orissa, where a canal was started in 1866 as a protective measure, after the famine that occurred there, but it has never been wanted since, and has not only been unremunerative, but has also done positive harm to the country by interrupting the natural drainage The upper part of the Western Jumna Canal is, similarly, not a success. Both in Behar and in *Instances*

the Bombay
have not paid
"failures."
and no one who has had experience of the loss of human life and of cattle in past times of scarcity, and will contrast it with the *protection afforded by the canals now, can for a moment* doubt the wisdom of constructing these very canals, although the expenditure may not have been directly recouped Nevertheless, in districts where wells can quite readily be dug, their extension rather than the replacement of them by canals should be sought. *In the Cawnpore district I have seen the wealthier cultivators* constructing masonry wells, although they had the canal flowing past their land They were, however, situated near the termination of the canal, and knew that the supply of water was precarious because of so much being used higher up the stream. But

on their wells they could always rely, and so they preferred to dig them rather than to trust to the canal

Construction of reservoirs at termination of canals

89. In district situated near the termination of a canal, and where consequently the supply of water must be uncertain, it is worth considering whether reservoirs might not be advantageously constructed which would serve as storage tanks for irrigation purposes At Cawnpore, during the hot season, I saw the crops of some Kachhi cultivators which were being quite ruined owing to want of water, for, although the canal was within a stone's throw and water was passing down it, there was not sufficient water to allow of the outlet to the cultivators' fields being opened, nevertheless, the stream, then flowing two feet deep, shortly afterwards found its way again into the river, and its benefit was lost to the land. Had there been a reservoir at the end of the canal, or some system of small tanks in the fields themselves, which could be filled and drawn from as required, less entire dependence could have been placed upon the uncertain canal supply.

Canals have interfered with the natural drainage and caused ill health to population

90 The second objection urged against canals is, that they have interfered with the natural drainage of the country, and that by raising the water-level, they have brought fever and ill-health to the people This, again, is a charge which has much to support it, but the Irrigation Department is fully alive to the necessity of avoiding these evils in the future, accordingly, new canals are now aligned with greater care Villages in the Etah and Cawnpore districts of the North West Provinces, others in the Delhi and Karnal districts, as also some along the Bari-Doab Canal in the Punjab, are known to have suffered from excessive canal irrigation, and to have become unhealthy on account of the faulty construction of canals, and a reduction of assessment has, in consequence, had to be granted This subject opens up a very serious problem for consideration Are the people to have the land left dry, and the climate healthy, though they themselves may suffer and die from the inroads of famine, or are they to reap an abundant harvest at the sacrifice of health? In other words, are they to drop off one by one by slow degrees and unnoticed, or are they to be swept away in numbers at a time by famine? This is, to put it plainly, the position that has to be faced The verdict, it seems to me, must be the one that actuated the appointment of a Famine Commission, and also their subsequent recommendation that, the preservation of the lives of the people being the chief concern, the causes which stand out most markedly as sweeping the population away wholesale must be first combated Beyond this, the only possible line of action seems to me to be the exercise of greater care in future alignment of canals, and the introduction of subsoil drainage in especially bad tracts. Subsoil drainage is, I am aware, a very difficult and costly matter in India, andfor the purpose of merely *reclaiming salty land* (*usar*) is hardly to be thought of, but where the lives of the people are concerned, and when there is undoubted evidence of the depopulation of water-logged districts, I do not see how the issue can be long delayed At all events, I think that subsoil drainage should be thoroughly

The problem of canal irrigation

Subsoil drainage as a remedy

put to the trial, in order to ascertain whether it can be carried out successfully on a large scale

91. Other objections to canal irrigation follow as consequences of the two main ones already noticed. It has been mentioned that the introduction of canals has been detrimental to existing wells. But it is urged also against them that they have caused the spread of the salty efflorescence termed *reh* (*see* paragraphs 67 and 74), in districts watered by canals. I endeavoured in the last chapter (paragraph 74) to explain the part which canals play in the production of *reh*, and to show that they supply the water necessary to dissolve the salts that lie below the surface and enable them to be brought to the surface by capillary attraction. I have pointed out, however, that, by flooding the affected land with silt-laden canal water, a remedy can be provided, and the injured land be practically reclaimed by means of the canal.

Other objection against canals

Spread of *reh*, etc

92. *Inundation Canals.*—In the Gangetic system (to which the perennial canals just described belong) the water of the dry and rainless season is utilised. There is then little or no silt, and the water serves rather as a substitute for rain than as a fertiliser. In the case of the Inundation Canals, on the other hand, the silt-laden waters of the rivers are carried at flood time to the higher lands, and thus afford greater benefit to districts were rainfall is deficient. As their name indicates, Inundation Canals are of use only in the rainy season, and they are taken off from rivers the banks of which are above the level of the surrounding country. Such canals are met with principally in the Punjab and in Sind. This system was in vogue before the time of the English occupation of India, and many of the canals were constructed and worked by the Natives themselves.

Inundation canals

93. *Canals or River-Channels from Spring-fed Rivers.*—These occur principally in Southern India, and do not differ except in their origin and methods of construction and distribution from the aforenamed snow-fed canals. It has been often pointed out that a great deal of water is allowed to flow down the rivers of Southern India and to find its way into the sea, whereas increased means of intercepting it before it reached the sea would result in a large amount of water being saved for irrigation purposes. Mr Nicholson, in his "Manual of Coimbatore," points out that much good might be done by storing the water of great rivers in reservoirs, and that it would not only supply irrigation, but would prevent a source of danger to the districts below, which arises from the sudden rushing down of the river at the beginning of flood time. In a Report on the Condition of Anantapur Mr Nicholson instances that the water of the Pennér and the Hagari rivers might be advantageously stored in this way, especially as the districts through which these rivers flow are peculiarly exposed to drought.

River channels from spring fed rivers

Possibility of storing water from rivers before flowing into sea

94. *Tanks.*—This term, as applied to the rain, stream, and river-fed reservoirs which occur principally in Madras and in Central India, is an incorrect one. They are in reality Lakes or Reservoirs

"Tanks."



formed by the erection of dams across depressions or valleys, and are fed either by the rainfall or by jungle streams and rivers They are largely utilised in Madras for rice cultivation, and it is certain that a very excessive quantity of water is often used from them I noticed this particularly at Salem Mr Nicholson reckoned that in Coimbatore as much as 12 feet depth of water in a season was used from tanks kept for rice cultivation Frequently the tanks are the property of individuals or communities, and are managed by them In some cases, however, the Irrigation Department undertakes the distribution of the water Better management in the repair of tanks is a matter calling for attention, and will be referred to later The supply of water from tanks which are merely rain fed must, at best, be looked on as precarious, owing to the uncertainty of the rainfall Tank irrigation is, however, preferred to any other for rice cultivation, but a cultivator will not begin to use a tank unless he knows that there is sufficient water in it to last him for his crop throughout its whole growth If the tank be full, he grows rice, if it is not, he grows other crops The consequence of waiting is that a good deal of water is wasted by percolation, and the tank may, after all, not be available It is difficult to suggest any remedy

Waste of water in rice cultivation

Cultivation by tank irrigation

Though tanks occur mostly in Southern India yet they are sometimes made in the rice-growing districts of Bengal, or else reservoirs are formed by throwing embankments across drainage hollows or natural slopes of fields, and are used for irrigating rice in the event of long droughts, when required, the banks are cut and the water is allowed to flow out Reports from Chota Nagpur show that while in some parts, Palamau, for instance, irrigation by these reservoirs is a necessity for rice, in others, such as Lohardaga, only a few tanks exist More might, however, be easily made and the rice be irrigated On occasions when drought has occurred, the villages that possessed embanked reservoirs have suffered no loss of rice, once at Banda, for example, the banks were cut, the water was led for four miles, and over 200 acres of rice were thus saved Even in the Central Provinces it is now under consideration whether in parts, such as the Mandla and Balaghat districts tanks should not be constructed for rice irrigation

Shallow tanks or ponds

95 *Shallow Tanks or Ponds* —These are the true Tanks, for they are excavated reservoirs, and are not merely those formed by embanking depressions or valleys, thereby holding up the water that comes The true tanks only hold the rainfall of the year, and dry up entirely in the hot weather Where the soil is clayey underneath is the most favourable spot for their construction, if the soil be sandy, without clay beneath, the water will soon sink in and disappear They are, of course, simply rain-fed, and are met with not only in the alluvial soil of Bengal and the Gangetic Valley, but also in parts of Bombay and Madras

Wells

96 *Wells* —I have left the consideration of wells until now, so that I may include under this head some of the principal differences that occur between cultivation by wells and that under other

means of irrigation. Irrigation by wells is at once the most widely-distributed system, and also the one productive of the finest examples of careful cultivation. I may fairly say that nothing in the agriculture of India impressed me so much as the excellence of the cultivation carried on by irrigation from wells ("garden" land). This was not the case merely in one or two parts only, but in almost every instance where this system of cultivation was adopted.

Excellence of garden cultivation.

Whether it be in the *betel* and plantain gardens of Máhim (Bombay), the market-gardening of Meerut (North-West Provinces), the "garden" land of Coimbatore, in Madras, or that of Gújrat and Hoshiarpur in the Punjab, the finest cultivation I have seen has almost invariably been that carried on by well irrigation. Here it is that the greatest care is given, and the greatest economy used, it is for this land that manure is most saved, and from it every weed is plucked away as an intruder, here every inch is utilised for growing crops—not one crop alone, but often three or even four together—and to these crops the precious water is dealt out, as it were, by measure. To take a single instance—at Máhim the *betel* plant is watered every sixth day [illegible] and after that every third day unti[illegible] the rains, plan[illegible] lays only. The explanation of the excellence of cultivation as carried on by irrigation from wells is found chiefly in the fact that every drop of water has to be raised by the *raiyat's* labour and that of his bullocks, and that the well itself has often been built with his own money and by his own hands. But I must not dwell on this except to say in regard to this cultivation that I can suggest nothing in it to improve, indeed, the people have mastered thoroughly all details of the system. English farmers may well join with me and look on in admiration, and it should be the aim of every one interested in agricultural improvement in India to extend this method of irrigation in every way possible.

Examples of garden cultivation.

Little or nothing to improve in this respect.

Further, as regards wells, one cannot help being struck by the skill with which a supply of water is first found by the native cultivator, then by the construction of the wells, the kinds of wells and their suitability to the surroundings and means of the people, also by the various devices for raising water, each of which has a distinct reason for its adoption. All these are most interesting points with which I am not called on to deal, for I see little to improve in them which the cultivator does not know perfectly well. I would, however, draw attention to Major Clibborn's valuable Report on the Construction of Wells in the North-West Provinces, where many particulars as to wells and well irrigation can be found.

Ingenious devices of the native cultivators for raising water.

97. As I have explained before, it is only exceptionally that cultivation by means of wells can be brought into comparison with that by canal irrigation, and it must be remembered that the value of the latter system consists in the fact that canals can often be brought where construction of wells is impossible. Where

Comparison of cultivation by well or canal.

the two systems exist near one another I have sometimes had the opportunity of comparing them Such was the case at Amritsar, Cawnpore, and elsewhere, frequently, too, wells are used, as at Multan, to supplement the canal supply and to ensure the safety of the crops Not only are the plots on well (or "garden") land kept very much freer from weeds, but infinitely more care is taken with the distribution of well water than of canal water, except, possibly, when the latter has to be raised by lift from the canal before it can be put on to the land When canal water is available the tendency is great to let the water flow on just as one would turn on a tap and allow it to run. No extra labour is involved and no extra charge is made for the quantity of water used, as the water rate is solely for the area brought to maturity But in the case of a well, all water raised has labour expended on it, and so the cultivator is careful that it is only used as the crop requires it and that it is made to go as far as possible The very appearance of the fields under the two systems of cultivation is different The beds, or *kyaries* as they are termed in the North West Provinces, into which the plots are divided by means of small embankments which direct the flow of water to particular parts, are numerous and small in the case of cultivation by wells, in canal cultivation, on the other hand, they are few and large. Colonel Forbes, the head of the Irrigation Department, pointed out to me that for every bed which exists in the case of canal cultivation there would be from five to eight beds on the same area if a well were used

Loss by percolation in water courses.

Major Clibborn, in his Report, remarks on the loss sustained through percolation in watercourses, especially in the case of long canal channels, and in village watercourses Well water courses, on the other hand, are short and are well-made as compared with those of a canal. The canal courses in villages are the property of the cultivators, and are made by them, but, as the villagers have no interest in the economy of canal water, the courses are often badly kept, and the loss by percolation is very great Advance in this direction might be effected if the Irrigation Department had more powers of construction and of improvement of watercourses, and if they could recover the cost by a small rate It is very difficult for an isolated cultivator to arrange for the water to run to his field when it first passes through his neighbours' fields The main courses, which are kept up by Government, are, as a rule, in excellent order, and the loss by evaporation and percolation is comparatively small.

Irrigation Department might have further powers over water-courses

Waste of water in flow irrigation

Although there is a rule to enforce the making of beds or compartments of a certain size, the *raiyats* who use the canal water will evade the rule if they can, and the canal officers find it difficult and harassing to enforce it stringently. In districts to which canals have recently come, the people are new to this particular mode of irrigation, and this fact affords another reason for the authorities not wishing to press too much at first for compliance As a consequence, water, when distributed from a well, is generally put on to just a sufficient depth and no more,

but canal water is often run on to an unnecessary extent Major Clibborn concluded from his investigations that rather more than three times as much water is used for irrigating an acre from a canal as from a well The average depths of water used were 0 9 inches from wells and 2 86 inches from canals This has led to a consideration whether, in future, canal water should not be supplied by "lift" only, instead of by "flow", but it is felt that the plan would not work, inasmuch as a cultivator will often wait until the last moment, in the hope that rain may come and so enable him to dispense altogether with the canal water, or rather, with having to pay the rate for it Thus, very frequently, he will not take the canal water until positively obliged to do so. Had he then to raise all the water by "lift," he would not be able to get enough labour to irrigate the whole area in the time, and the canal would fail in accomplishing its object

Should all canal water be raised by "lift"?

Similarly, all attempts at devising a scheme for payment of water by the *quantity* used have failed

Failure of attempts to fix payment of water rate by quantity used.

At Multan, Ferozepore, and Shiyali, I observed instances of beds or compartments being made too large, at Hospet, on the contrary, far more care was exercised, and the compartments were not much larger than in "garden" land

In the Punjab it is found, as the result of increasing canal irrigation, that the tendency is to grow more wheat This is the case whenever the canal runs long enough to supply moisture for sowing the crop, inasmuch as a single fall of rain afterwards, about January, suffices for wheat

A disadvantage in cultivation by canals as compared with that by wells is that in the latter case a man has always some work to do, and is more independent than if he relies on a canal which may only be let on to his land at intervals Hence when there is the chance of giving the land a good soaking the tendency is to put a great deal more water on it than is really necessary.

Again, a *raiyat* is not so careful in levelling his field when he uses canal water as when he has to raise water from a well, and thus waste is incurred with canal water

98 This leads me to the consideration of ' "

of the land, consequent on the introduction

The Report of the Famine Commission recor

deterioration of soil has followed the coming of canals into districts previously unsupplied by them Undoubtedly, with the introduction of a canal into a district comes also the tendency to force the land to bear more crops than it ought to, unless it be plentifully supplied with manure, which is seldom the case, also, the careless use of the water causes the washing out of those constituents of the soil which should form part of the crops Moisture and heat are necessary to bring the soil constituents into activity, but over-watering not only produces a state of stagnation and coldness, but goes farther, and actually removes the very plant food which it has been instrumental in bringing into an assimilable condition

nitrate of soda, carbonate of soda, common salt, and salts of magnesia To this is, no doubt, due the *believed fertilising quality* of the well water, in other words, it is owing to the large amount of salts held in solution

Incidentally it may be mentioned that, as regards organic purity, both waters are good, and have but little ammonia though a water with so much salts dissolved in it as the well water has would probably not be palatable

Need of further chemical study

This is but one analysis of well water, but, from my observations, I am sure that the composition of the water varies very greatly in different parts In some cases the salts, instead of being beneficial are considered hurtful to crops A chemical study of this subject would lead to interesting and useful information, and give definite knowledge instead of the present uncertainty that exists

Analyses by Mr Venis

I have found a record of two analyses of Ganges river water, taken at Benares, by Mr G Venis, which show the total solids contained in the waters to be 16 52 and 19 95 grains per gallon respectively These figures do not differ widely from my own The dates of Mr Venis's samples were December 19th 1888 and February 6th 1889

Removal of superfluous water

100 Having spoken of the means of supplying water, it is well to mention also means of removing water, or rather, of preventing the harmful effects of a rapid flow of water. Some of these have been instanced already Thus, improvement of land cut up by ravines has been spoken of in Chapter V, paragraph 70, subsoil drainage and damming up of rivers, in paragraphs 90 and 93 of the present chapter A further plan is that of embanking arable land, in order to stop the rapid flow of water over its surface at the beginning of the rainy season It is in the Central Provinces, perhaps, that this has been most effectually tried, for it has been found that by embanking fields the rich topsoil is not washed away and a quantity of water is also held up, which comes in usefully for irrigation later on Great encouragement has of recent years been given to the spread of this practice, more especially by the issue of vernacular notices to the effect that such improvements will be exempted from assessment at the next Settlement The Administration Report of the Central Provinces for 1888 89 says, on page 8 —

Embankment or *band ng* of land.

Much done in Central Provinces.

Encouragement given to practice of *band ng*

"The failure of rain in October 1888 showed the advantage of embanking land the bunded fields retaining moisture enough for sowing whilst the open land was hard and dry

In some parts of the Central Provinces it is found that by holding up the rain water a crop of wheat can be taken after the rice

elf, but

'rust.''

termed,

on, it

would be washed away to a considerable extent It is well to point out that it is not so much the total quantity of rain that falls

but the amount that falls at one time, that may do harm to the land.

It is possible that a good deal of existing swampy land might be reclaimed by draining the water off, but this could hardly be carried out unless a Government grant for drainage purposes were made. Draining of swampy land.

101. I might now indicate, by way of instances, some districts which came under my notice, and which stand in need of further irrigation. In the Punjab, Multan and Hissar are two places where a quantity of land could be brought under cultivation if canals were more extended. The success of the Sidhnai Canal has been mentioned, but there is also a great unwatered tract enclosed between the rivers Chenab, Ravi, and Sutlej The land here is rich, all it wants is water. At Hissar, too, the canal supply is very uncertain. Districts in need of further irrigation. The Punjab

In the North-West Provinces, Mirzapore is badly off for irrigation; there is none from canals, and but little from wells Agra, Gwalior, and Jhansi are all precarious tracts. The first named is on the edge of the "shrinkage" of the monsoon, *i e*, the monsoon rains may stop short before reaching them. Gwalior is likewise badly placed, the wells are 60 feet deep or more, and the district is too far off for irrigation to be satisfactorily brought to it. At Jhansi, wells are over 40 feet deep; *bunding*, as stated, is being tried here. There is also scope for extension of well digging near Cawnpore. North West Provinces

In regard to Bengal, mention has been made of the good that would follow the making of irrigation reservoirs in Lohardaga (Chota Nagpur), and Mr Basu mentions tracts in the valley of the Amanat and the plain of the river Son where irrigation canals and reservoirs could easily be made Bengal.

In Rájputana, Ajmere is known as a precarious district which the monsoon frequently does not reach. Parts of the Deccan, [illegible] irrigation, whilst, coming down to [illegible] instances Anantapur is one of [illegible] idency, being badly situated for [illegible] orth-east monsoons, there are only about 37 wet days in the year, and, with an annual rainfall of only 23 inches the water soon dries up Tanks are, therefore, very uncertain. Bellary, Kurnool, Coimbatore, and Madura are also very precarious districts At Bellary the wells have to be made in the *solid rock*, and are 45 *feet down*, there are no canals, and but few tanks Kurnool has few wells, the supply of water is poor, and the water itself often brackish Coimbatore, being situated on high [illegible] have to be ta [illegible] dura there is [illegible] that can be [illegible] here The pos [illegible] y is shown b [illegible] gle-put district alone the Government have advanced 2½ *lakhs* (say Rajputana Deccan Madras

2,000*l.*) to enable 19,000 more wells to be begun. Mr Nicholson has pointed out, also, that the waters of the Pennér and Hagari rivers might usefully be stored for irrigation purposes, also that a storage scheme for Kallapuram, whereby 2,000 acres might be irrigated, is quite feasible The centre of Mysore is another part which is very poorly off for water, and wells might, with great advantage, be constructed The possible advantage of tanks in certain districts of the Central Provinces has been indicated, as also the benefits that would follow the embanking or *bunding* of and The Saugor district is a case in point

Mysore

Central Provinces

Interdependence of water and manure

102. There is a matter which I do not wish to pass over, but the full consideration of which I postpone to the next chapter, I mean, the interdependence of water and manure The one without the other is productive of but limited good, and in most cases, it may be said that either of them alone is useless An estimate given by Sir Edward Buck, in reference to land near Ajmere, expresses this point as follows —"Irrigation from tanks is lavish, and it is put on to lands which it has robbed of its fertility, as the manure supply, before deficient, is now totally insufficient to restore fertility Given unlimited manure, water will raise the rental of land to Rs. 50 an acre, with no manure it will sink to 1 rupee an acre"

Agency by which improvement of agriculture by better supply of irrigation may be effected

103 We must now consider how the extension of the different systems of irrigation, according as they are best suited to each case, may be carried out

Minor works may be done by the people themselves aided by Government

Major works must be constructed by Government

Where minor works have to be constructed, such as the digging of wells of a moderate depth, the making of shallow tanks, and the embanking of land, these may be entrusted to the people themselves, aided by a judicious system of "advances" of Government money for the purpose of beginning such works To this system of advances the name "*taccavi*" is given.* In a later paragraph I will endeavour to show what improvements in the working of this system may be effected But for all works of greater magnitude, such as the carrying of canals over the country, the taking of channels from rivers the formation of large reservoirs or tanks, dependence can alone be placed on Government It is true that in former times the people themselves made inundation canals, and constructed large reservoirs which are still objects of admiration but the people are not so likely now to construct fresh ones, but rather to rely on the Government, besides this, whatever may be said of the excellence of the earlier constructions, the engineering skill of the Irrigation Department is now able to carry out more effectual and lasting work. It is to assist the people in works which they can carry out themselves, and to do what they cannot do, that the efforts of

* *Taccavi* system—a system by which advances of money at a low rate of interest are given by Government to cultivators for agricultural improvements, and mainly for the digging of wells. The rate of interest charged is 1 pie per rupee per month or 6¼ per cent per annum

Government should be put forward The initiative must now rest more than ever with Government, and, as I have pointed out, a careful enquiry is necessary in the case of each separate district, so as to ascertain exactly what its irrigation requirements are, and how best they may be met It should be a main duty of Agricultural Departments to set on foot such enquiry The duty of Agricultural Departments.

104. The last paragraph leaves still open for further consideration the agency by which wells of more than ordinary depth, or those which have to be made under circumstances of special difficulty, are to be constructed To give instances — The making of wells in rock land. Instances

In the Coimbatore district of Madras the wells are frequently in rock, and are large and costly, the depth varying from 15 feet to 40 feet, while they have to be wide also, in order to include a spring within the area. At Bellary, similarly, I noticed that wells had to be cut through rock to a considerable depth, and had also to be made very large Mr Nicholson, in his "Manual of Coimbatore," speaks of wells as "being the "mainstay of revenue and the *raiyat*" and he says —"Unless "by great irrigation schemes or development of wells, it is "not probable that production can keep pace with human "reproduction" In another place he says —"Well irrigation "alone prevents minor famines," but he also instances frequent cases where "wells have been begun and given up "because of the interposition of impenetrable rock" In my own enquiries in these parts I found that the cultivators often shrank from taking Government advances for digging wells, because of the chance of rock intervening, and the consequent difficulty of cutting through it, they might have to go to an uncertain depth, with the chance of not finding water soon enough to make the well profitable to work, and thus they might expend the whole advance and yet not obtain water

The ignorance of the *raiyat* in the matter of "blasting" of rock is a further hindrance

It is worthy of remark that in the last great Madras famine it was the deep wells that held out, so that a decided advantage follows their construction in precarious districts, an advantage which must be looked on in the light of a "protective" measure, and not as distinctly remunerative It appears to me therefore, that in cases of difficulty, where, on account of deficient rainfall and absence of canals, the agriculture absolutely depends upon wells, it is fully worth considering whether Government might not undertake the construction of wells In other cases, however, it is probably better that the cultivator should be encouraged to construct wells himself, he chooses his own spot (and no engineer could do it better), and he employs his own labour and materials Wells could undoubtedly be constructed more cheaply with the landlord's materials than with those which the Government would have to obtain and bring to the spot. Construction of wells by Government

It is only in exceptional cases, therefore, that I consider the construction of wells by the State is desirable But it would

be easy, in many cases, to make the system of Government advances more known and more popular, and to induce the cultivators to avail themselves further of its advantages

Major Clibborn, in the report already referred to, in paragraph 97, concluded that, as regards the North West Provinces, a rate of *Rs.* 2 per acre of annual irrigation would cover the outlay of construction of wells The cost would, of course, vary in different parts according to the depth and nature of the soil passed through. But it must be remembered that Major Clibborn was dealing with alluvial soil and not with hard rock, such as is met with in Madras. He reported that Government could not safely undertake the construction of wells on a large scale, but that they must leave this to the landlords (*zemindars*), and to the working of the *taccavi* system. (*See* footnote on page 80)

Proposed scheme in Madras

Since my return from India I have heard from my friend, Mr R H. Elliot, of a scheme which he has laid before the Government of Madras for the digging of wells by Government in unoccupied fields, and the loaning them out to cultivators at "wet" rates of assessment. In Madras, it must be explained, the waste land belongs to the State, and it is not an uncommon practice for a *raiyat*, after cultivating a field for some time, to throw it up and to take another, the field so thrown up remaining in the hands of Government until a fresh tenant is found. In this way enormous quantities of land may be in the hands of the State at one time Mr Elliot now suggests that if the Government were to dig wells in these unoccupied fields, or perhaps even on waste lands, and thus gradually turn them from "dry" to "wet" lands, not only would the country be protected against famine, but the revenue might, in the end, be very greatly enhanced Such a project is one which would carry with it great benefits, though it is obviously only where a land system similar to that of Madras prevails that it could be adopted

Much can be done if Government are prepared to regard works as protective measures

There is no doubt that a great deal can be done in improving the water supply in precarious districts, if Government are prepared to look on the measures taken as those of a "protective" and not purely a remunerative nature This is well expressed in a note by Colonel Mead, Chief Engineer for Irrigation, Madras He said in 1887 —

"Much can, no doubt be done to improve the existing supply to tanks "if Government are prepared to accept the benefit to the *raiyat* as a sufficient return for outlay incurred, and to consider the works as entirely "protective in nature

Management of small tank by the people

105 I found a very general expression of opinion, both in Madras and in Bombay, that the management of small tanks should be left in the hands of the village communities, or else be under the Collector of the district, and not be administered by the Irrigation Department At Belgaum there are a great many tanks, and these are managed by the villages, the water

being let out for a group of 100 fields at a time, the *raiyats* settling among themselves how it is to be used.

On the other hand, the management of canal branches by the people has been tried and has not been found to be successful. Thus, the Eastern Jumna Main Canal was made by Government, but the branches by a joint-stock arrangement of the cultivators, the Government advancing money for the purpose. The cultivators, however, could adjust neither the sharing nor the payment among themselves, and Government had finally to take the management into their own hands. It has been found also in Southern India that there has been considerable neglect shown by the people in keeping irrigation channels in order. The people allow underwood to grow, and let the leaves fill up the channels and there decay, one place after the other becomes malarious and the people leave, going higher up the stream. So, too, in other parts weeds are allowed to overgrow tanks, and then the people go lower down, and leave the Government to clean out the tanks. Management of canal branches by the people unsatisfactory

106 Improvement can certainly be effected in providing for the more prompt and better repair of tanks. Mr Nicholson, in his "Manual of Coimbatore," mentions the case of Kondampatti village, in Udamalpet, where the repair of a large tank is quite feasible. In Bengal, Burdwan is mentioned as a part where repair of tanks is difficult, and Palamau as a division where there are many reservoirs which are out of repair. Once when at Poona, I met a number of landowners and others interested in agriculture, and an unanimous opinion was expressed by them in favour of the management of small tanks by the communities themselves and not by Government, and especially that the repairing of these should be left to the village communities. Repair of tanks; improvement in this respect possible

The same opinions were expressed to me on the occasion of a similar gathering at Madras. Going on from Madras to Madura, and then to Coimbatore, more precise particulars were given me, not by landholders, but by actual cultivators. In the Madura district, where there is much tank irrigation, there were complaints of the difficulty in getting repairs done and a desire was expressed that this work might be put under the Revenue Department rather than the Department of Public Works, the Collector being considered the person who knows the wants of the people best. The cultivators instanced the delay that takes place when a tank wants repair, how that when the *Tahsildar* hears of it he goes to the divisional officer (Assistant Collector), the latter to the Collector, the Collector to the Executive Engineer of the Public Works Department, the Executive Engi-
[illegible] in this
[illegible] for three
[illegible] whether
it is a matter of first or second importance, and so on. Altogether it is a long business, and, in the end, the year's crop is generally lost. Under the old system, I was told, the Executive Engineer was the direct subordinate of the Collector, and small works

requiring no special skill could be effected at once by the Collector's direction. It was, of course, necessary for *large* engineering works to be enquired into and to wait, but three quarters of the "major" work (anything over 200 acres of irrigation being considered "major" irrigation) was simple work of repair, putting up *bunds*, digging channels, digging tanks, etc, which any workman could do, and which needed no particular skill

Classification of tanks desirable.

It would appear desirable, from what I gathered, that there should be a classification of tanks, and, in accordance with this, it should be determined which tanks should be managed and repaired by Government, and which by the village communities It is clear, anyhow, that good might be done by a simplification of the process by which repairs are effected Necessarily there must be official enquiry as to any work of magnitude, but in nine cases out of ten the repairs required are those which call for *immediate* attention, and which, if neglected, may produce very much aggravated consequences If the circumlocution that has been instanced could be avoided, and a certain amount of discretion and executive power be given to the Collector to have these repairs effected *at the time*, the local needs would be more readily met, and expense be, in the end, spared

The system of *taccavi* advances.

107 It remains for me to refer to the system of Government advances known under the name *taccavi* * Though not confined to the purposes of digging and repair of wells, it is mostly for these that the advances are used, and they are the schemes which are the most satisfactory in their working Advances are also given for embanking of land, for purchase of cattle, purchase of seed, and occasionally to assist in payment of debts. The advances are made by Government at a moderate rate of interest (6¼ per cent. per annum), and are intended to save the people from being compelled to resort to the money-lender or *baniya*, who charges a rate of 12, 18, or more per cent, and out of whose clutches the cultivators seldom get The plan is an excellent one, but its success depends entirely upon how it is worked, and how nearly it is brought home to the people, and is adapted to their means What is still requisite is, to make it clear to the cultivators that the system is one that will benefit them, one that will enable them to benefit themselves. If this idea could be once thoroughly grasped, the advantages, not alone to the people, but to the Government, in the form of an increased revenue from the land, would be very great.

The different ways in which it is administered in different parts.

Anyone going through the country as I did, could not fail to be impressed forcibly with the difference between the way in which the *taccavi* system is worked in one part and that adopted in another, and also with the dependence of the system, for its success, upon the energy and interest of a single individual, this being, as a rule, the Collector or Deputy Commissioner Whilst the system is popular in some districts—

* *See* footnote on page 80

for instance, in Belgaum (Bombay), the Native State of Kapurthala, Multan, and other parts of the Punjab—in others, such as Aligarh (North West Provinces), it is reported that "the people will not have it on any terms," and in Madura, Coimbatore, and other parts of Madras the complaints are great as to the difficulties put in the way of making use of the advances for the digging or repair of tanks.

When advances are made by Government agency the returns show that it is but seldom that there are arrears of any long standing, and the State loses very little on this account. The objections of the people to avail themselves of the advances do not arise alone from difficulties put in the way, or because the advantages of the system have not been sufficiently impressed upon them, but largely, also, from their own fault, their careless and improvident habits their suspicion, and their inability to appreciate what is intended for their benefit. *The most important factor in removing these hindrances is* the personal interest and activity of the Collector or Deputy Commissioner.

The objections of cultivators to the taccavi system

The cultivator will often prefer to resort to the money lender, because the latter gives him the advance at once, because he asks no questions, and does not insist upon the money being devoted solely to the particular purpose for which it is given, he does not come round and see that the work is being carried out, but allows repayment at leisure, lastly, he has no intermediaries who require to be "feed". When, however, a cultivator applies for a *taccavi* advance, he complains (and frequently with reason) that the delays are long, and that the enquiries are put off, that he has often to wait several days at the *Tahsildar's* office before that official will attend to him, and that, in the end, the advance frequently comes too late to be of any use, that he is bothered by minor officials who come to see that he has not used the advance for other purposes, by others, again, who come to "pass" the work, but who one and all require their "palms" to be "greased," and that the money, thus filtering through several hands, never comes to him to the full extent of the advance, lastly, that the Government insist on punctual payment of interest and repayment of loan. Thus the *raiyat* comes to undervalue the advantages of the *taccavi* system, and resorts to the easier method of going to the *baniya*, though it may be dearly bought in the end. Then, having once obtained the money, he will often use it for marriages and for other extravagancies rather than for the presumed object, and thus he gets involved deeper and deeper in debt.

Scope for extended adoption of the taccavi system

108 I will now give some instances of the need that exists for the cultivators to be made more acquainted with the advantages of the *taccavi* system, and also of the need for better administration of the system.

North West Provinces

At Rura, near Cawnpore (North-West Provinces) I saw a cultivator who was constructing a masonry well at a cost of Rs 150. This was a tended

to irrigate 25 acres The cost was being paid partly out of the man' savings, partly by gifts from his family, and the remainder was borrowed from the money-lender The man *knew nothing about Government advances* Other cultivators here said the same thing

Punjab

In the Punjab Administration Report for 1888 89 it is noted, in regard to the Gurgaon district "*Tahsildars* need constant reminding of the "desirability of encouraging advances A lot has been done in Rewari, "but there is no reason why the number of wells should not be doubled "in the district, also well repairing should be done by *taccavi*. The "payments, when advances are made, are very punctual"

Bombay

At Ahmedabad (Bombay) I found that the *taccavi* advances were not made use of The *Mamlatdar* did not like the trouble attaching to them, his objection was that he had to keep separate accounts for them

Central Provinces

In the Central Provinces, at Saugor, only two wells have been dug by means of Government advances in the last three years Of Dongasara it is reported "There might be more wells here, and the *malguzars* (land-"lords) could easily make them" The Chief Commissioner (Mr Mackenzie), in his proceedings for the year 1888 89, points out that it is not the *debt* to the *baniya* that ruins the *raiyat*, but the high rate of interest and the way he is cheated in settling his accounts with the *baniya* Also he instances a case where in one division there was an extremely high mortality of cattle, and where the people would surely have been glad had help been given them and yet there was not a single loan for purchase of plough cattle, and this entirely because the Deputy Commissioner did not trouble about it

Speaking of Bilaspur, Mr Mackenzie says "The fact is, that the granting "of loans is opposed by the whole weight of the treasury and *tahsil* "establishments, and it is not till a Deputy Commissioner has made it "plain that no obstruction will be permitted, that people are able to "obtain loans with reasonable facility"

When at Madras, I met in conference a number of landholders, they one and all spoke of the difficulties in the working of the *taccavi* system, and at a similar conference at Poona it was remarked that local officers did not trouble about *taccavi* because it entailed extra work on the *Mamlatdars*, *Tahsildars*, and others, and they had to keep separate accounts for it

Madras

During my tour in the Madras Presidency I came across many instances of the non-use of *taccavi* advantages At Salem I found that only four or five wells had been sunk in the last two years by Government aid The people preferred to borrow locally at 12, 15, or even 18 per cent, and not to be restricted in their application of the money At Avenashi (Coimbatore) *raiyats* borrowed locally at 12 per cent in preference to using the Government loan I was told that in Tinnevelly the risk of taking the *taccavi* advances was, that if a man took a loan and tried to dig a well, he had to pay whether he was successful or not, and the rocky nature of the ground made the attempt very uncertain In cases where a man has tried and failed, I think, possibly, the rules might with advantage be relaxed

Bengal

In many parts of Bengal the landlords (*zemindars*) have no direct interest in the produce of the land so long as they get their rents, and they are often too encumbered to lay out capital in water supply, the *raiyats* are too poor to do anything unaided, and, in consequence, reservoirs that use to benefit low lying rice fields have fallen out of repair, and no fresh ones have been constructed.

Instances of energetic administration of the taccavi system.

109. By way of contrast, I may now mention cases where manifest advantage has followed the energetic administration of the *taccavi* system, and the popularising of its objects and advantages

Punjab

In the Punjab Administration Report for 1888-89 it is said, "The increased resort to *taccavi* is in many cases due to the personal influence of Deputy Commissioners" Again, "In the Montgomery district the system of advances is undoubtedly popular"

In the Multan district I found that the Deputy Commissioner had, in the last year alone, given Rs 28,000 in *taccavi* advances for the digging of wells to supplement the supply of water from the Sidhnai Canal

Bombay

In Belgaum (Bombay), and entirely through the personal energy of the Collector and District Deputy Collector, advances to the extent of between thirty and forty thousand rupees annually have been made during the last four years, and the number of applications have averaged 748 per annum Advances are made for well and tank digging and repair, for embanking, for removing rank grass and weeds, for levelling ground and making rice fields out of dry land, for purchase of seed and cattle, and for cutting away prickly pear The District Deputy Collector (*Honourable Gur-* [illegible]) seven years [illegible] ming o the [illegible] take it up [illegible] and now all [illegible] the system. [illegible] and so much work has been thrown on the *Mamlatdars* that three extra clerks have had to be obtained for this work, the cost being paid out of the *taccavi* grant. The District Deputy Collector explained to me that everything depends on the prompt examination of applications, and on not keeping the applicants waiting about at the *Mamlatdar's* office, or sending them to and fro repeatedly. The only reason that advances were not even more used was, that the people had already mortgaged their lands so much for other debts that they had no security to give for the Government advance He was of opinion that it was absolutely necessary for the people to be ready with their payments on the day fixed, and that it would not do to allow them any laxity. With this opinion I am inclined to agree, and, though at first I thought that where security was good some liberty might be shown, I now believe that strict enforcement of payment when due is advisable

Central Provinces

At Wardna, in the Central Provinces, through the personal energy of [illegible] and in the Central [illegible] up of the advances [illegible] cing exemption of [illegible] Mr Fuller, in his [illegible] ure, speaks of the [illegible] deprecates delay in [illegible] be let know that [illegible] entailed on them

Mr. Fuller reports, further, that very great progress has been lately made in the amount of the loans advanced under the Agriculturists' Loans Act (No XII of 1884) The figures for the last three years are as follows —

YEAR	Number of Loans	Amount
		Rs
1887-88 – – –	1,144	26,000
1888-89 – – –	1,692	45,285
1889-90 – – –	2,535	1,07,409

Such a marked increase is highly satisfactory, and shows what can be done by the exercise of personal energy. It is added that, "in the whole of the Central Provinces recoveries were "made without difficulty; in only one case was resort to coercive "measures found necessary; Government realised 6·4 per cent. "on its outlay under the Agriculturists' Loans Act" Of Bilaspur, which has been mentioned in paragraph 108 as having been backward in utilising the advances, it is now said, "for "several years it was reported that the people were reluctant "to take advances, but in 1889-90 Rs 16,768 were advanced "here alone."

The *taccavi* system in Native States.

110. Native States have not been slow to realise the advantages of advances for agricultural improvements

Jeypore.

In Jeypore the cultivators are *not allowed* to borrow money for sinking wells, the State advances money at interest varying from 6 to 12 per cent, and the Land Revenue has increased very considerably wherever wells have been dug

Kapurthala

In the Kapurthala State under British administration, the system of giving advances for agricultural improvements has been made easy, and is largely used Within the past two years Rs 65,482 have been distributed,

[illegible]

form of advances to free them from the professional money-lender Advances are given for new wells for repairs, for purchase of plough cattle and seed, and for redemption of mortgage In 1889 there were 246 new wells under construction and 73 under repair, and nearly one half the increase of wells during the last 10 years had been made by means of *taccavi* advances Major Massy reports that repayments are generally made with punctuality, and that there is still room for extension of well sinking Advances for [illegible]

that would follow.

Necessity for removal of difficulties and complaints of cultivators

111. The foregoing instances show clearly how much has been done, and also how much can still be done, if only the matter be made a *personal* one Were further demonstration needed, it would be found in the case I have mentioned in paragraph 101, *viz*, that during the quite recent distress in Madras the Government advanced money to the extent of 20,000*l*. in the Chingleput district alone to enable 19,000 new wells to be begun. Besides this, nearly 10 *lakhs* (say 72,000*l*.) were advanced in the Kurnool, Bellary, Anantapur, and Cuddapah districts for well digging, and 1¼ *lakhs* (say 9,000*l*.) under the Agriculturists' Loans Act.

The want of capital on the part of the *raiyat* is undoubtedly a main source of the difficulty in enabling him to undertake

the construction of wells, tanks, etc, on his own account, and, therefore, the aid of Government may most advantageously be called in to assist him and to better the agriculture of the country But it is incumbent that every reasonable difficulty that stands in the *raiyat's* way, and which prevents him from availing himself of the advantages, should be removed

I do not say that the objections and complaints of the cultivators are valid ones in general, or that the indifference of the people is not mainly their own fault, but there are ways *in which procedure may be simplified, and the system of* advances be made more popular And here, while suggesting some improvements, I would desire not to be misunderstood, nor to hint in any way that Government are not fully alive to the importance of urging on their district officers the carrying out of the system, nor, again, am I forgetful of the great good that has been done in the past But the subject is one which cannot be forced too often or too strongly upon the notice of Government and its officials.

Ways in which the taccavi system may be rendered more popular

112. In the first place, the issue of vernacular notices, setting forth the advantages of *taccavi* advances, should be more widely adopted, and these should be supplemented by the personal activity of the district officer. In certain cases as has already been done in some parts there might be added special inducements to the taking up of the advances, such as the securing of exemption of improvements from assessment at the time of the next Settlement I am quite aware that the Government have declared in India generally that they will not tax improvements effected by private capital, including those made by means of *taccavi* advances, but, as a matter of fact, this promise is rendered nugatory in many parts, *inasmuch as taxation is raised, not on account of the improvements* directly, but on the general grounds of rise of prices, construction of new roads, extension of railways, and other means of communication, consequently, there is no certain security under the present system that private improvements will not be taxed As long as this continues, it will certainly act as a bar to agricultural improvement, and will prevent the outlay of private capital on wells and minor works of irrigation I think, therefore, that the system should be relaxed at least to the extent of securing to the man who digs a masonry well that he shall not be directly or indirectly liable to any rise of taxation on account of the improvement which he has effected by the expenditure of his private capital upon it

The non taxation of improvements

There is little doubt that had such a provision existed in reality as well as in name, a great many more irrigation works would have been carried out by private effort A single instance will make this clear In a Resolution of the Revenue Department of the North-West Provinces and Oudh, No 598A of 1889, a comparison is drawn between the four districts Gazipur, Jaunpur, Ballia and Benares which are

under permanent settlement as regards the Land Tax, and the adjacent and similarly situated districts which are temporarily settled, and, consequently, are liable to periodical revision of the Land Tax. In the former, 55 per cent of the cultivated area has been brought under irrigation by wells, tanks, and streams, and in Jaunpur alone 55,224 wells have been dug by private capital. But in the temporarily settled districts only between 16 and 17 per cent. of the cultivated area has been brought under irrigation from wells and other sources, exclusive of canals If the land under canals be added, there is, even then, only a total of 22 per cent of the whole cultivated area of the temporarily settled districts under irrigation, as against 55 per cent in the permanently settled districts, there being no canals at all in the latter. Private efforts, therefore, under these circumstances, have done far more than all the aid of Government, even including the making of canals The points here brought out are well worthy of consideration, and it has further to be remembered that anything which induces the people to invest money on the land gives them a permanent interest in the continuance of the English rule.

Avoidance of delay in giving advances and in making repairs.

Next, all hindrances to and delay in giving advances must be removed. The *Tahsildars* and others must know that it is not a matter of their choice whether or when they will attend to applications, but that it is their clear duty to expedite the advances A fair interval must be allowed for an improvement to tell, before payment of instalments is called for This done, I am in favour of strict adherence to the rules as to payment on the date when due, and I think that the rate of interest is well within the cultivator's means

Again, repairs should be more promptly attended to, and minor repairs, as also the management of the smaller tanks, should be left to the village community themselves, or to the Collector's authority.

In certain cases, such as that instanced, where a man, after taking a *taccavi* advance for digging a well in rocky ground, has failed to reach water, the rule might be relaxed in his favour, if it be clear that he has spent the advance in the endeavour.

Transference of surplus from one district to another

113 An improvement might be effected in the method of disposing of surplus funds accruing from grants made for *taccavi* purposes

When the *taccavi* grant for any district has not been fully applied for, so that a surplus is over, this surplus might well be transferred to another district where the applications may have exceeded the original grant made for the purpose

Allocation of money to district officers which must be spent for advances

It is also worth the consideration of Local Governments whether a certain sum of money should not be given annually to each Collector or Assistant Collector, which he would be *bound to expend* in advances for wells or similar improvements This would not leave it so much a matter of choice as it is at present with the

district officer whether he will exert himself or not in the giving of advances for agricultural improvement

A share in the administration

In the last place, I am strongly of opinion that some share in the administration of *taccavi* [illegible] of the Provincial Agricultural [illegible] unwise to take any step which [illegible] the existing Revenue Authorit[illegible]ments, and, therefore, the control and disbursement of *taccavi* advances could hardly be entrusted to the Provincial Directors of Agriculture But, at the same time, the Director of Agriculture is the person who should best know the agricultural needs of his Province, and he should be enjoined to give his special attention to the extended working of the *taccavi* system. Further, he should be empowered to advise the Revenue Authorities generally, and to report on specific cases, either of special need, or of non observance in the application of the funds which have been granted

The duty of the Director of Agriculture

It is a misfortune attending the position of the Director of Agriculture that he has no immediate executive power, but he should certainly, I think, be entrusted with the share in the administration of the *taccavi* advances which I have indicated.

CONCLUSIONS.

CONCLUSIONS

114 Inasmuch as differences in agricultural systems are found to be largely due to differences in the facilities for water supply which are possessed by various districts Improvement in Agriculture will be effected by any means which modify these existing differences Of this nature are the extension of irrigation to dry and precarious tracts, the carrying of canals to districts which have no other system of irrigation available, and the digging of wells where canals cannot be brought The agency by which such work can be carried out is twofold The people can construct minor works, such as the digging of shallow tanks, the embankment of land, and the making of wells of moderate depth But the carrying out of major works, such as the construction of canals and the formation of large reservoirs, can be achieved only by Government The efforts of the people should be assisted by encouragement given to them by the State, and, in particular, by the fuller and freer application of the system of *taccavi* advances

The Government and the Irrigation Department have done a great work in the past in pushing on irrigation schemes which have been of enormous benefit to the country, all that is wanted is to continue the work I have shown that there is still great scope for extended action in this direction More particularly can an immense deal be done by making known and by popularising the *taccavi* system, and by providing for the more prompt repair of tanks

The special work of Agricultural Departments in this connection is to make an "agricultural analysis" such as that referred to in the Government of India's Resolution of December 1881, whereby the requirements of each district in the matter of irrigation may be ascertained, as also the best means by which the improvement may be effected In such an enquiry the assistance of an expert engineer is required, and that of a chemist may also at times be useful

RECOMMENDATIONS

115 I recommend —

The extension of Canals and other means of Irrigation to districts which are in need of them

The encouragement of minor works of Irrigation by rendering the system of *taccavi* advances more popular

The giving to Agricultural Departments of a share in the administration of *taccavi* advances

The prosecution of Agricultural Enquiry in order to ascertain the requirements of each district in respect of irrigation

CHAPTER VII.

CHAPTER VII

Manure.

Manure

116 This subject, like the foregoing, is one of the very highest importance in a consideration of Indian agriculture and its possible improvement Water and manure together represent, in brief, the *raiyat's* chief wants. In some respects the latter is the more important requirement, for, whilst attention has already been turned to the supplying of water for agricultural purposes, but little has been done towards giving the *raiyat* more manure The reason is, I believe, that whereas no one has doubted the value of water, and it can, moreover, in many cases be brought from outside and redundant sources, the means of supplying manure, on the contrary, do not appear ready at hand, and there has been, and still is, uncertainty as to the use and value of ordinary manures such as cattle dung, bones, oil seed refuse, nitre, etc This is principally due to a want of [illegible] to practical agriculture [illegible] ttle manure loses any of [illegible] it makes any difference how manure is preserved and stored, whether urine has any value, whether bones ought to be used in the country, or might be allowed to go for export While this is the case, it is hardly to be wondered at that Government are not anxious to take up the [illegible] that of [illegible] nyone [illegible] e able [illegible], con- [illegible]

Absence of application of scientific knowledge to practical agriculture in India

117. In Chapter V, when dealing with the question of the possible exhaustion of the soil (paragraph 50), I quoted several instances in which reference is made to the importance of manure, and to the insufficiency of its supply for keeping up the soil's fertility. Also, in Chapter VI, (paragraph 102), the difference between manured and unmanured land was shown in the case of Ajmere. The following further examples may be given —

Importance of manure

Mr Nicholson writes in reference to Coimbatore —

"That progress is possible cannot be doubted In seasons of serious drought such as in the north east monsoon of 1881 there were a few "acres of decent crop on land absolutely similar and contiguous to that "producing a most *nil* crop and in one case the *cholum* was almost equal "to that of garden land This was simply due to *manure* and the careful "cultivation of small area

Again, speaking of Erode, Mr Nicholson says —

"No greater contrast save between garden and ordinary dry crops can "be seen than between the ordinary upland crops especially in a year of "poor rainfall and the very same species of crop on a piece of newly reclaimed

CONCLUSIONS

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used alike for drinking, washing, and irrigation purposes Here, too, the manure from cattle, the sweepings of the houses, etc , are nearest at hand, and are available for the fields closest by, these being also the ones frequented by the people for purposes of nature As a consequence, it is here that both water and manure are most used, and that the richest and best cultivation is carried on, sugar cane, poppy, castor oil bean, potatoes, and vegetables of all kinds being grown This is the inner circle, or "garden" culture. Next comes a circle lying beyond this, but neither so much manure nor yet so much water can be spared for it, and the crops, though still good, are not so good, nor, as a rule, of such a remunerative character, pulses, wheat, barley, and oil-seeds are more general Next is a third or outer circle, which is only partly manured, and only occasionally watered, and where cultivation is still less high Lastly, there may be a fourth or outlying part, never bearing more than one crop a year, a summer crop one year, and a winter crop the next This land gets no manure and no water except the rainfall, and may be termed "dry" land Thus, one is able to draw, as it were, successive rings or belts round a village, each belt, as it is further removed from the centre, indicating less intensive culture, and also the close interdependence of water and manure. The rent may accordingly vary as I found it do in a village near Bilhaur, from Rs. 30 in the central zone, to Rs 15 in the second, Rs 10 in the third, and Rs 7 in the outlying portion This was repeatedly pointed out to me by Sir Edward Buck during our tour in the Cawnpore district.

It may be said, generally, that manure goes first to the "garden" land (watered by well), then to the "wet" land (watered by "flow"), and what is over goes to the "dry" land (watered by rain only).

It is not that the soil was originally different in quality, though this may sometimes have been the case, thereby inducing the people to pitch their habitations where it was best, but it is mainly the manure, the water, and the resulting cultivation, that [illegible] le use to extend [illegible] to back it up [illegible] there is plenty of manure, but it is not made use of because there is not water enough Bengal, on the other hand, furnishes many instances of an abundant rainfall, but deficiency of manure As a contrast to both these, Meerut and Hoshiarpur are examples of what can be done by a sufficiency of each, night soil being largely used there in conjunction with well water Similarly, Amritsar and Poona prove what can be done with canal water and manure It is a common saying that, if you give a *raiyat* water and manure he will grow a crop even upon stones!

119 The Indian cultivator shows by the money which he is willing to pay for manure when able to afford it, that he is by no means ignorant of its value. When he burns the cow dung which he collects, he does it, as a rule, rather from necessity than from want of knowledge of its worth That, when he has manure,

Indian cultivator not ignorant of value of manure

he often does not preserve it well, or use it to best advantage, is, however, the result of ignorance.

[illegible]

At Mâhim (Bombay) I found that Rs. 60 an acre was quite an ordinary amount to spend in manure for the "garden" crops. Even larger sums than this are expended over *betel* vines, as much as Rs. 250 to Rs. 300 an acre being given out in manure, while for ginger, sugar-cane, and plantains the cost frequently goes up to Rs. 100 an acre. A cultivator thus graphically described to me the effect of manure on the ginger crop he was cultivating; he said:—"I use manure, and 3 or 4 sons come to each plant." At Poona, as much as Rs. 200 per acre is spent on manure for sugar-cane; at Amritsar, Rs. 43 an acre for the potato crop; at Hoshiarpur, Rs. 60 an acre for sugar-cane.

Nor is it in the quantity of manure alone that the Native often displays great foresight. He also often knows *when* to put it on, and for *which* crop to use it. He knows that he must not use it on "dry" land but on "wet" land, where it will decompose. He knows, too, the harm of using *fresh* dung, and that it will attract the white-ants, and that they, in turn, will destroy the crop.

Plan of present chapter.

120. I propose now to review the different ways available in India for manuring the land, and then to see to what extent each manure is made use of, to consider what relation its supply bears to the wants of crops, and how the supply may be improved and extended.

Cattle-manure.

121. The most general manure, alike in India and in England, is cattle-manure, or, as made in England, farmyard manure. But, whilst in the latter country it has to be, and can be, supplemented, and even in part replaced, by artificial manures, this is not the case in India, and cattle manure is the universal fertiliser and often the only one available. When, therefore, we find it the general practice, even in villages, to burn a large proportion of the dung from cattle as fuel, and when, on nearing any town, we may see troops of women carrying in baskets on their heads, the cow-dung cakes or *bratties*, which they have made into cakes and dried in the sun, we cannot but pause to ask ourselves whether the burning of these cakes as fuel does not imply a great agricultural loss. Some have maintained that it does not, for they say that the ashes are saved and used on the fields, and assert that is practically the only thing of value in the dung; others hold that, even if the nitrogen be lost in the burning, the cattle are so poor, and so poorly fed, that there is but little nitrogen to lose, for the dung is of very low quality, whilst even what is lost, is recovered in the extra amount of nitrogen which exists in the rainfall in India. *Such statements as these have been made*, even quite recently, by men who, though not agricultural chemists themselves, have not hesitated to express boldly their opinions on points which they were not able to investigate for themselves, nor were qualified to pass judgment upon. And so it has come about that, from an error as to the amount of nitrogen in the rainfall, many theories have been built up, and but little real investigation has been done. I do not

Statements made as to the poor quality of Indian cattle manure and the small loss in burning it.

mean to say that I have been able to investigate the question at all thoroughly, but I have done so sufficiently, at least, to satisfy myself of the incorrectness of many of the theories propounded, and to show that cattle-manure in India is not the poor miserable stuff it has been represented to be, but that it must, and does, lose a very great deal if it is burnt for fuel, this loss *not* being recovered in the rainfall Even *were* the latter to be the case, we should have a further difficulty, the districts of slight rainfall, where most dung is burnt (because wood is most scarce there), would get least nitrogen back, for the greater part would be transferred to the more rainy and more wooded tracts.

To satisfy myself on these points, I obtained, through the kindness of Mr R H. Elliot, of Bartchinhulla, Mysore (whom I was visiting at the time), a number of samples, not only of the solid droppings of cattle, but of the urine and the drainings from manure heaps, also samples of the ashes of *the same dung after burning cakes made from it*, *samples of* leaves used for litter, of castor oil refuse (*castor poonac*), earth nut cake, etc I must not burden this part of my Report with all the analyses, but, referring to the Appendix for these,* I will now only give sufficient data to enable a comparison to be instituted between English and Indian cattle manure, and to establish such other points as I may wish to demonstrate The samples taken were sent to London, and analysed in my laboratory there The cattle dung was composed of the solid droppings of lean working bullocks, taken when fresh and put in a tin box, thus reaching me simply in the air dried condition Analysis A is my own, analysis B is one by Mr John Hughes, of London, of the sun dried cakes, C is a standard analysis of English farmyard manure, D is an analysis by myself of the ashes left after burning cakes made from dung similar in composition to that given in column A, E is an analysis calculated from the results quoted in columns A and D My own investigations

* For full analyses *see* Appendices D, E F G, H, J, K

TABLE VIII.

Analyses of cattle-manure

ANALYSES of CATTLE-MANURE (Indian) and FARMYARD MANURE (English)

	A	B	C
	Dung of Lean Cattle (Indian) [Air dried.]	Sun-dried Cakes of Cattle manure (Indian)	Farmyard Manure (English)
Moisture	19·59	7·22	66·17
* Organic matter	59·26	65·32	28·74
† Mineral matter (ash)	21·15	27·46	5·09
	100·00	100·00	100·00
* containing nitrogen	1·34	1·49	·65
equal to ammonia	1·63	1·80	·79
† containing—			
Sand	14·43	19·62	1·76
Oxide of iron and alumina	3·36	—	·42
Lime	1·04	1·96	1·35
Magnesia	·44	—	·15
Potash	1·16	·63	·67
Soda	·34	trace	·08
Phosphoric acid	·47	·54	·31
equal to tribasic phosphate of lime	1·03	1·18	·69

TABLE IX.

Analysis of ashes of cattle-manure

ANALYSIS of ASHES of CATTLE MANURE (Indian)

	D	E
	Ashes of Cattle-manure (Indian) after burning	100 parts of the Cattle manure (Column A) would approximately contain after burning 20 parts of Ash thus —
Moisture	2·01	·89
* Organic matter	2·40	
Oxide of iron and alumina	[illegible]	1·85
† Phosphoric acid	1·37	·28
Lime	1·76	·35
‡ Alkalies and magnesia	2·97	·59
Siliceous matter	80·20	16·04
	100·00	20·00
* containing nitrogen	·17	·034
equal to ammonia	·20	·040
† equal to tribasic phosphate of lime	[illegible]	·93
‡ containing potash	2·03	·59

REFERENCES

Analysis B.—Journal of the Society of Arts, Vol. xxxviii, No. 1,948, March 21st, 1890, page 441.

Analysis C.—Johnston and Cameron's Elements of Agricultural Chemistry and Geology, pages 316, 317, and 318.

Hughes, side by while the sun- the fresh dung, yet, taking this into account, the general composition of the two materials is very similar, thus showing that my analysis A is not that of an *exceptional* sample, but of a fair average one This makes my deductions from column E all the stronger

Comparing analyses A and C, the Indian dung has, it will be seen, far less moisture, but, as a consequence, the organic matter in 100 parts is very much higher. The large amount of sandy matter in Indian dung is noticeable, but in other mineral constituents, notably phosphoric acid, it is quite as good as English manure, while it has double the amount of nitrogen. This is, of course, taking the two manures just as they are used, and comparing them weight for weight, but to meet objection, even if we suppose the Indian dung to contain, not 19 59 per cent of water only, but 66 17 per cent like the English farmyard manure, the amount of nitrogen in it would be 563 per cent. This is only a little below the 65 per cent of the English sample, and that, by the way, one of well made dung Therefore, whether we consider them on the same basis of moisture, or whether we take them as we really have to do with them, *viz*, weight for weight, the small value and inferior quality of Indian cattle-manure is by no means established In this connection it must be remembered that the Indian dung is made without litter, and is merely the solid droppings of the cattle, with more or less earth whereas English farmyard manure consists of a quantity of litter, as well as of the solid and liquid excrements of the cattle. Indian cattle manure is not poor

Now let us consider what takes place when the dung is burnt Analysis D shows the composition of the ashes in 100 parts, but, in order to institute a comparison, I have added column E This is calculated from analysis D, on the assumption (founded on analysis A) that 100 parts of the original dung will leave, after burning, 20 parts (one-fifth) of ash In analysis A the actual amount of ash was 21 15 per cent, in another analysis which I made it was 20 25 per cent; 20 per cent, or one fifth, is taken for the sake of convenience It will be seen that 100 parts of the original dung (analysis A), containing over 59 parts of organic matter and 1 34 parts of nitrogen, lose, on burning, practically *all* the organic matter and nitrogen The nitrogen is reduced from 1 34 to 034 per cent, in other words, for every ton of cattle manure that is burnt, 29¼ lbs out of a total of 30 lbs of nitrogen (97 5 per cent) are altogether lost. Great loss results from burning it; 97 5 per cent of the nitrogen is lost.

In Chapter V (paragraph 59) the idea was fully combated that this loss was made good by its return in the extra amount of nitrogen supposed to be contained in the rainfall

Mr Hughes, in the paper from which the analysis B is taken, remarks that, while the nitrogenous organic matters are lost in the process of burning, "the mineral matters, "which include the lime, potash, and phosphoric acid, remain

"in the ashes, and if these were returned to the land *the only* "*loss* (the italics are my own) would be the 33 lbs of nitrogen "(the quantity in one ton of manure), equal to 155 lbs. of "sulphate of ammonia for every ton of cattle-manure so "employed" But I would point out that, even were this the *only loss* it would imply a very considerable one indeed The 155 lbs of sulphate of ammonia, putting the cost of the latter at 12*l* per ton, would mean, even in England, no less an outlay than 16*s* 7*d* to replace the nitrogen thus lost by burning a ton of cattle-manure Hence the loss is not a slight one at all, but a very heavy one, and, if it costs so much to replace it in England, it cannot be a matter of indifference that so much nitrogen is lost to the soil of India by a wasteful practice But this is not all, for there is another point that must not be overlooked, *viz*, that the entire value of the *organic* (or vegetable) matter is lost in the burning, and this is a matter of no small moment when, as I have shown, soils in India are generally notoriously poor in vegetable matter.

The organic matter also lost; its influence physical and chemical

Nor even this alone, for dung has an important *physical* as well as chemical effect on the soil, and it acts as a retainer of moisture Indirectly it may be said, therefore, that the heat of India is increased by the burning of cattle manure, the soil losing the advantage of the moisture holding material. In some cases the physical or mechanical effect of dung is quite as great as its directly manurial one This is not possessed by the ashes, and would be entirely lost in the burning It is not necessary for me to pursue this further than to say again that the statements made as to the small value of Indian cattle-manure, and the small loss that takes place when it is burnt, are incorrect My analyses are, of course, those of single samples only, but they were taken quite in the ordinary course, and are confirmed by Mr. Hughes' results I am, however, well aware that much more extended work and enquiry than I have had leisure to make are needed before facts are established for India in the same way as they have been in England Nevertheless, I shall have shown by these examples how very great is the need of careful scientific enquiry in connection with agriculture, in place of the conjectures and theories of the past

Cultivators do not burn dung for fuel unless obliged to do so through scarcity of firewood

122 I have spoken of the practice of burning dung as being a general one, and so it unfortunately is, but it is very far from being a universal practice among cultivators, pure and simple. I would go further and say that the best cultivators do not burn dung except out of sheer necessity, and because they have nothing else for fuel, and that, even amongst second rate cultivators, a great majority will not burn dung if they can help it. Perhaps in all my enquiries there was none into which I looked more closely than this, as I had heard and read such diverse opinions about it, consequently, wherever I went, I did my best to inform myself upon it As the result, I have no hesitation whatever in saying that amongst *cultivators* the reason why they burn dung is that they

have no wood, and that if wood could be made cheap and accessible to them, there would be an enormous increase in the amount of manure available for the soil I can instance place after place which I have visited and where no cultivator burns a scrap of manure for fuel, or where the least possible quantity is so used—generally only a little to boil milk Coimbatore, Salem, Madura, Gujarat (Bombay), Nadiad, Hospet Hoshiarpur, and Multan are cases in point It is where, as in the North-West Provinces, wood is dreadfully scarce that the practice of burning dung has grown into a habit, and I have been told by people well acquainted with the North West Provinces only, that the people will never give up the practice, and *must* use dung for their cooking But what I have seen in other parts, where not a morsel of dung is used even for cooking, or for boiling milk, convinces me that, if firewood were provided, the cultivators would soon come to know the benefit of saving their manure for the fields Those resident in villages, but not themselves the actual cultivating classes, will doubtless continue to burn dung, and near a town there will always be the inducement of realising something by the sale of cow dung cakes The seller does not appreciate that the cakes have cost him anything to produce, that they are really his crop taken off his land, and he returns from the town happy with the two annas or so of *ready money* which he receives in return for a donkey-load or head load of cow-dung cakes If he buys firewood, on the contrary, he has to *pay* money away instead of *receiving* it When, however, one gets away from the towns, it will be found that manure is rarely a purchaseable article The reason why dung is used as fuel for cooking and especially for boiling milk, is, I believe, that it gives a slow fire which does not need any attention, whereas a wood fire does There are also ideas that cow dung imparts to the food a particular flavour which the people like, but as I have said there are many places which I have been to where cow dung is not even used for this purpose Cow dung fuel is a handy form in which a Native can [illegible]

123. I give some instances, from my own observations and from the reports of others, which bear out the opinion I have expressed Instances in support.

At Hoshiarpur there is plenty of firewood and comparatively little dung is burnt the cultivation here is by wells Visiting Rash da near Multan where the Sidhnai Canal comes I found that the cultivators do not burn dung with the exception of a little for boiling milk Punjab

In the North West Provinces as stated the scarcity of wood is perhaps greater than anywhere else and so the burning of cow dung cakes has become from necessity almost a habit even among cultivators But what is more frequently the case is that for four months November to February the *raiyat* makes cakes for burning and during the other eight months the dung is used as manure Sometimes I have found that the cakes are made during eight months and that the manure is used for the fields the remaining four, in each case the rains determine the date for during the rainy season cakes for fuel cannot be made North West Provinces

Thus, a cultivator near Cawnpore, belonging to the *chamar* or leather-dresser caste, told me that he made cakes for three months, and collected dung for his fields the other nine months dating from April 1st in each year An *Ahir* (goatherd) near Rura made cakes for four months (November to February), but collected manure the rest of the time, except a little which he burnt for boiling milk, and for his pipe (*hookah*), a Brahman here told us that he burnt as little dung as he possibly could A *Kachhi* at Cawnpore who had dug a well for himself, and grew vegetables largely, made cakes for eight months in the year, and burnt them, but only because he had to pay so much money for firewood He was in the habit of buying the stalks of indigo and *arhar* (a pulse) to eke out his fuel, and, in addition, he purchased the town-sweepings to put on his fields

Mr Moens, in his Settlement Report of Bareilly, says, "three-quarters "of the available cow dung of every village has to be consumed as fuel, for "want of wood"

At Rasurpur, near Aima, I found that manure is sold to other villages, but the reason of this is, that the village is a cattle and not a tillage one at all

Bengal

Travelling in Eastern Bengal, in the neighbourhood of Serajgunge, I noticed that the general practice among the cultivators was, to have two [illegible] good cultivator would [illegible] of manurial value is put in the dung-heap Here there is plenty of jungle

Reports from Lohardaga, Palamau, Pachasa, and other parts of Bengal say that dung is "not a marketable article," or is "seldom bought or "sold"

Central Provinces

I cannot give any instance from the Central Provinces in which dung was not regularly burnt as fuel But, as it is well known, here, if anywhere, the soil requires no manuring, and one would accordingly expect less care in the preservation of dung

Ajmere

At Biawar, near Ajmere, some dung is burnt, and some is kept for manure The supply of water is unfortunately, short, and this prevents as much manure being used on the land as might otherwise be the case

Bombay,

At Ahmedabad, firewood is scarce, it costs Re 1 for four maunds of 40 lbs each, and the testimony of the cultivators is, that they gather all the stalks, etc, off their fields, and would not burn any dung if they could possibly help it. Poona is another place where firewood is expensive It has to be carted between 30 and 40 miles, and then costs Rs 5 a cartload, whereas a cartload of cow-dung cakes costs Rs 3, and a cartload of loose cow-dung Re 1 only It is not to be wondered at, then, that the cakes are burnt as fuel instead of the wood The general opinion expressed was, that if the price of wood were halved the cultivators would not burn cow-dung, for they fully appreciate its value

The country around Nadiad is well wooded, and no *Charotar Kunds* (the best cultivating caste) burns dung, not even for cooking purposes *Manure is sold out of the town to the cultivators, they paying Re 1 for* 20 maunds (of 40 lbs each)

Mr Leyts says of Gujarát (Bombay) —"Here manures are largely "used Cow-dung is not burnt."

Madras

It was, perhaps, in Madras that I found the strongest ground for concluding that cultivators, if they had firewood in sufficiency, would abandon the burning of dung as fuel.

At Averashi (Coimbatore) the cultivators do not burn dung at all, but, on the contrary, they buy it from the people who keep cattle, but have no fields themselves This is not because of any plentifulness of firewood, but because by growing hedges and clipping them, and by gathering all stalks, etc, the people manage to eke out their stock of fuel without having to burn the dung No cultivator at Salem burns dung, although those who live in the town and keep buffaloes will make up cakes for burning The same is the case at Shiyali

At Hospet there is plenty of wood, and consequently dung is not burnt, except just a little for boiling milk. Firewood at Hunsur (Mysore) has

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Bengal Travelling in Eastern Bengal, in the neighbourhood of Serajgunge, I noticed that the general practice among the cultivators was, to have two heaps of dung, one for fuel and one for manure

Mr Sen writes of Burdwan —" In Beerbhoom no good cultivator would "think of using his cow dung as fuel Everything of manurial value is "put in the dung heap Here there is plenty of jungle

Reports from Lohardaga, Palamau, Pichasa, and other parts of Bengal say that dung is "not a marketable article, or is "seldom bought or "sold

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Kardai or Safflower '" ·'' · ' ' ·· · " ` ed, Mustard seed, Niger seed Cotton seed The seeds of the as *Pongamia glabra*, *Bassia latifolia* (the *Mahua* tree) and *Melia Azadirachta* (the *Neem* tree) are also pressed, and the refuse is employed as manure, chiefly in the coffee districts Most of these seeds, after expression of the oil, are also used primarily for feeding cattle, and secondarily for manure

Castor oil is a plant grown very largely in Gujarát (Bombay), and it is a common sight to see it fringing the fields in the North-West Provinces, also in Bombay and Madras In Mahim, where, in consequence of heavy and continuous rain, it is hard to preserve cow dung, castor refuse, obtained from Gujarat, is used to a surprising extent for the more expensive crops Thus, for *betel* vines, from 9 to 12 tons of castor cake per acre costing Rs 280 to Rs 380 will be carefully applied in handfuls round the base of the plants, in some 15 to 20 separate doses for ginger, sugar-cane, and plantains, lesser amounts, but still costing from Rs 60 to Rs 160 per acre, are used Castor refuse is also employed at Poona, Burdwan (Bengal), Hoshiarpur (Punjab), and elsewhere, but in many places it is merely thrown on manure heaps or else burnt as fuel Its cost varies from Rs 20 to Rs 35 a ton An extensive use for it is found in the coffee growing districts of Coorg and Mysore, where it is known as *castor poonac* Castor-cake.

An analysis which I made of a sample of *castor poonac* from Mysore showed it to contain—

	Per cent.
Nitrogen	4 52
equal to Ammonia	5 49
Phosphate of Lime	2 86

Accordingly it possessed manurial properties of decided value

Gingelly cake is often fed to cattle, and is also exported Earth nut is grown mostly in Madras, and especially in So Arcot, it goes mainly for export Rape seed and Mustard seed are similarly exported Niger seed is not largely grown, it yields a good burning oil, and the residue is used as food for cattle Linseed is almost entirely an export crop Cotton cake is generally fed locally to cattle The other seeds mentioned have mostly only a local significance, but from the flowers of the *Mahua* tree (*Bassia latifolia*) a spirit is obtained by distillation, the spent material being used as food for cattle fruit of the *Mahua* tree, when allowed to ripen, contains a seed from which a valuable oil is expressed, and the residue is used as manure under the name *Bassia* cake For the particulars as to the various oil-seeds I am mainly indebted to Dr G Analyses of several of the varieties of cakes are given in Appendix *

* *See* Appendices J and K

the neighbourhood of towns and villages for the purpose of "parching" grain

I believe that in these various ways of green-manuring, the *physical* improvement of the soil is an important point At the same time it shows that the value of vegetable matter, as an addition to the soil, is not neglected by the *raiyat*, although some would maintain that its loss in the burning of cow dung is of no account.

The *rāb* question

131. Associated with the use of twigs, leaves, etc, for manure is the system of seed-bed cultivation termed *rab* * This system is employed mainly in the Bombay Presidency throughout the districts of heaviest rainfall, but it is not unknown in parts of Bengal The crops for which it is chiefly used are rice and a millet called *nágli* (*Eleusine Coracana*). The word *rab* literally means "cultivation" The process consists in heaping on the spot selected for the seed-bed successive layers of cow dung, tree loppings, shrubs, leaves, and grass, with earth on the top to keep all down, the heap is made about three feet high, and then the whole is set fire to.

As regards the advantage, still more the necessity, of *ráb*, there have been continuous contentions between the cultivators and those who have supported them, on the one hand, and the Forest Department on the other, the latter maintaining that the practice is a wasteful one and that the lopping of trees injures the forests greatly. In 1885 a Forest Commission was appointed in Bombay to enquire into the matter, and Mr Ozanne, Director of Land Records and Agriculture, Bombay Presidency, conducted a number of experiments, which, though not absolutely conclusive nor complete, went far to show that the *raiyat* in *rab* areas was adopting the only ready means by which he could cultivate his rice crop with profit Great credit is due to Mr Ozanne for the energy which he showed and the line of enquiry he adopted. He pointed out that there are defined limits to *rab* cultivation, *viz*, the districts where rainfall is very heavy and also continuous For example, *rab* exists in the Konkan, whereas in Dharwar, where the rainfall is less heavy, it does not Similarly, *rab* is not used where there is tank irrigation, for by the aid of the tank the seed can be sown before the heavy rains come Mr. Ozanne's experiments also showed that brush wood and shrubs when used as *ráb* material give just as good results as boughs of trees do, and that there is nothing in the *raiyat's* belief in the superior virtues of particular kinds of trees Cow dung (which the *raiyat* prizes most for *rab*) gave the best results of all, the supply of it is, however, limited, but, with the aid of brushwood, shrubs, and grass, the cultivator can make up the necessary amount for burning. In this way the Forests had, up to the time of the enquiry, been of great use to agriculture.

Mr Ozanne's experiments in Bombay

It is undisputed that *transplanted* rice gives far and away the best return, and that only the finest kinds of rice are so sown. At

* See footnote page 27

Igátpuri, where, owing to scarcity of *ráb* material, a good deal of rice is grown from "sprouted" seed (the seed being allowed to soak for two days in water before sowing), the out-turn is not so good as at Kalyan where *ráb* prevails If seed is "sprouted" and sown, but the rain does not then last, the seed is wasted, but *rábed* seed is not put in the seed-bed until the rain actually comes. The assessment of the land has of late been lowered at Igatpuri, on account, it is believed, of the difficulty in getting *ráb* material, and the consequent lesser yield of rice Rice though aquatic, cannot stand immersion, and it is noticeable that where *ráb* is practised the seed bed is always on elevated ground Rice cannot be sown in the wet, as it would rot, this accounts for *ráb* being used at Mahim, inasmuch as, apart from the difficulty of preserving the cow-dung in such a climate, if it were put on the seed-bed it would tend to hold the moisture all the more By burning the dung on the land a drier and more porous soil is obtained

At first sight, I allow, one would conclude that the practice must be a very wasteful one, but the fact that it is carried on by *raiyats*, such as those at Máhim, the excellence of whose cultivation excited my highest admiration, obliges me to conclude that, though I cannot explain *why* it is, yet *it is* the *one* way in which the cultivator can grow his rice to best profit I cannot believe that men who annually
do in the purchase of c
for *rab* if they had not f
best plan to adopt In other words, I am content to learn from practical experience, and to endavour to explain the science from the practice The advantages of *ráb*

It is not at all unlikely that much of the benefit of *ráb* is due to the change produced in the mechanical texture of the soil by the burning which it undergoes This results in the liberation of some of its dormant constituents, and the supply of ready-formed food for the plant, which, at this stage, needs to be quickly forced on, then, again, the addition of mineral matter from the materials burnt must conduce to the richness of the soil, and, while supplying plant food, would, at the same time, render the soil porous, so that it would not retain excessive moisture, as might be the case were natural manure or green leaves to be used There is a further possible benefit in the destruction, through burning, of any weed seeds which might choke the rice in its early stages I find it stated in the Lohardaga Agricultural Report that:— Possible explanation

"for paddy nurseries in many parts the manure heap is set on fire first, the motive being to kill grass seeds, which where the soil is poor, would "germinate and kill the rice, but this is not done in Five Parganas, since the "land is fertile there and the young crop grows up strongly enough to keep "the weeds in check."

This instance from Bengal may afford a possible explanation of what takes place in other parts The whole subject of *ráb* is an interesting and important one, about which there is still much to be learnt, and on which the scientific agriculturist may usefully work

Manuring by silt or by soil-mixing

132 Another system of manuring is that by using silt, tank mud, etc, or by the mixing of soils of different character, in order to improve the texture of the land

Silt from rivers, streams and canals

Vast areas in Bengal are annually renewed naturally by the silt of rivers, and there are in the Punjab, for example, near Gujrat, stretches which are covered yearly by the silt brought down by mountain streams In the Jhelum and Shahpur districts, at the foot of the Salt Range, there are similar tracts; here the fields are first embanked, and then the flood water of hill torrents is turned into them through an opening in the upper end of the embankment The water is allowed to flow in until the field is converted into a pond When this dries up, a crop is sown, and requires no further watering or rain. In this way the wheat-growing areas of these districts are formed, and no manure is used or needed, the coming of the silt supplying more fertilising matter than many manurings could

In Behar a large proportion of the land is inundated, and the soil is washed from the higher to the lower land, the latter consequently not requiring manure

Jute growing in Eastern Bengal is carried on by the annual *renewals of silt from the rivers, and where it comes no manure is* needed at all

It is found that wherever there is silt the *raiyat* does not value ordinary manure or take trouble in preserving it, he looks for the silt to come instead

In the case of silt laden canals one reason for the excessive use of canal water is, that the more water that is used the more silt is [illegible] en known [illegible] The use [illegible], nd for reclaiming the latter, has been mentioned (see para 75)

Great distinctions are drawn by the cultivators between the rivers and canals which bring silt and those which do not Thus, the Sutlej is a snow fed river, and brings sand rather than mud, the silt of the Jumna is considered fertilising, that of the Ganges is not.

Soil mixing

[illegible] ough- [illegible] going [illegible] one [illegible] jute [illegible] pond

At Nadiad (Bombay) I noticed another kind of "soil mixing" Here the fields are all surrounded by hedges growing on embankments When it is required to turn a field into a rice field, the topsoil is thrown from the centre up against the hedge, thus making an embankment, the level of the field is lowered thereby, so that the rain water, when it falls, is held up and soaks the soil thoroughly When, in turn, the field requires to

be manured, the soil is thrown back from the hedge side on to the field and is spread over it

133 Nitre or saltpetre (nitrate of potash) is a salt with which the soil in many parts of India is impregnated, and the manufacture of nitre, together with some common salt by a somewhat crude process of extraction and purification, may be seen very frequently. Though the manufacture is widely distributed, it is in Behar and the North West Provinces that most nitre is made The earth around the remains of old villages is specially found to be thus impregnated The accumulations of the salt in all probability have their origin in the natural process of nitrification (production of nitrates) which the solid and liquid excreta of cattle and men, as well as vegetable and other refuse, have undergone. Wood and other vegetable ashes supply potash in the form of carbonate of potash, which then combines with the nitrates, producing nitrate of potash The potash in the soil itself, more especially when the soil is clayey in nature, no doubt, contributes also to the production of nitre This explanation accounts for the nitre containing earth being found mainly where habitations formerly stood.

Nitre or saltpetre

Its method of formation

The men who manufacture the salt know by tasting the earth whether it will pay them to work it or not

Nitre as a manure is but little used, owing to its high price Experiments at Government Farms have shown that it gives a considerable increase in the out turn of cereal and other crops, but these experiments, like several others, have not been conducted with a view to seeing if the extra return would pay for the expenditure, and if there be a likelihood of the *raiyat* availing himself of the manure The price of crude saltpetre varies in Behar from Re 1 As 8 to Rs 3 per maund (of 80 lbs), but the lower-priced kind would be very impure Generally speaking it may be said that its cost locally is Rs 2½ to Rs 3 per maund of 80 lbs This is the price at Cawnpore, also at Salem (Madras) In Gujarat (Bombay) nitre costs nearly Rs 5 for the same weight, and delivered at Calcutta, the price is from Rs 5 to Rs 6½, according to quality

Price

The price of saltpetre accordingly, puts it quite beyond the reach of the ordinary cultivator, and it is only in the case of crops which bring in a large monetary return, such as sugar-cane, coffee, tobacco, opium, and indigo, that it has any chance of being used in the country Thus, it becomes almost exclusively an article of export, principally to the United Kingdom In Coorg, among the coffee planters, a small amount is used as manure Occasionally, too, the Natives will use the nitre containing earth itself as a manure, spreading it round the base of the sugar-canes, etc I saw the earth being used for canes at Hoshiarpur, and also for wheat at Hissar An efflorescence of nitre often appears on the walls of houses in villages of the North-West Provinces and Oudh, as well as on the earth around them, it is then scraped off and used as manure

Use as manure.

Reference has been made in the last chapter (Chapter VI, para-

Well water containing nitrates

graph 99) to well water which is termed *khara* by the cultivators, and which is held in special repute for tobacco-growing. Nitrates, as I have shown in the analysis there quoted, hold a very prominent place in the composition of such waters, although, in that instance, rather to my surprise, I found that they existed as *soda* and not as *potash* salts. It is quite possible that nitrate of potash occurs in other cases, but the subject needs more complete investigation. In another instance, when at Avenashi, I noticed a white crust on the soil, and the cultivator said that it was prejudicial to his sugar-canes; he added that it came from the well water. He did not grow tobacco here because the water was not of the *kind of brackishness* he liked. As far as I could tell from a cursory examination, the saline crust on the soil was sulphate of soda, but whether it came from the water or from the soil no one could tell me. I only mention this to show that the Native clearly discriminates between the properties of different waters, though he does not know whence they arise, and also to show the amount of useful work that could be done by a chemist who would investigate these various points.

Wood ashes

Other sources of potash are wood ashes and the ashes from burnt cow-dung cakes, these, as we have seen, are not wasted, but generally find their way on to the manure heap.

Lime

134 Lime is seldom, if at all, used as a manure. Nor, as we have seen in Chapter V (paragraph 63), is its use generally required, the soils of India, as a rule, containing a sufficiency. Were there to be need of its special application, an abundant supply would be found in the concretionary limestone known as *kankar*, which in so many parts underlies the soil.

Kankar

Gypsum.

A further supply of lime, in another form, is available from the vast beds of gypsum (sulphate of lime) found in the Salt Range in the Punjab, which are capable of supplying almost inexhaustible quantities of lime. Some experiments that have been carried out seem to point to the possibly profitable use of gypsum as a manure for indigo, and support for this may be found in ... r. Indigo, like ... soils of Coorg ... lack of lime in ... ould, I am con- ... , reports to me that lime, where put on, has done good Unfortunately, it is in these parts that lime is hardest to procure. In Coorg and Mysore a compost for coffee is made out of the pulp from the coffee berries mixed with lime, soil, etc.

Phosphatic manures

135. Bones are practically the only source of supply of phosphates to the soil Small quantities of apatite and phosphatic nodules were found by Dr. Warth and Mr Parsons at Mussoorie (North-West Provinces) in 1884, and by Dr Warth, in the Eocene of the Eastern Salt Range Coprolites have been discovered in spots in East Berar and the Upper Godaveri district in Hyderabad, but nowhere in anything like sufficient quantity to be profitably worked Nothing else that I know of in the way of

Few mineral sources discovered

raw phosphatic material for manufacture into manures has been found in India

Fish manure, which may be considered partly a phosphatic manure, is prepared in parts along the sea coast, such as Mangalore (Mysore), and is transported inland within certain distances, being used *almost entirely by the coffee planters of Coorg and Mysore.* Fish manure

I pass now to the more important consideration of the use of bones.

136. Bones, as is known, are very extensively exported from India, and are but little used in the country itself. The question Bones

the trade in and use of bones. The general reply received was that the export was an increasing one, that the trade was carried on entirely by European capital, and that the actual collection of bones was done by Muhammadans and low-caste Hindus, that it was principally confined to districts served by railways, and from villages within an easy distance of the line, and, lastly, that bones were not used by the native agriculturists. It is estimated that 60 million cattle die or are slaughtered annually in India. The export of hides and skins amounts to over 30 million yearly, though the number is not an increasing one, for more raw hides have been used in the country itself of late. In 1888-89, as also in 1889-90, 6½ million raw hides were exported from India to foreign countries, 1¼ million dressed hides, 4 million raw skins, and 19 million dressed skins. Whether taken from the number of hides or from the estimate of the cattle that perish, it is evident that there must be a very large supply of bones available. Hindus, however, being largely a non-meat-eating people, and regarding the bones of cattle as those

the animals may happen to die, or are thrown into ditches (*nullahs*) and ravines and left there. It has also to be remembered that India

and,

break

up in the collection and export of bones, it has increased and is still increasing. Almost the whole amount collected is sent to the United Kingdom, where the use of bones, either raw or else manufactured into artificial manures, is valued highly. The exports of bones from India have been, in round numbers, as follows:— Amount exported

Year	*Tons*	*Year*	*Tons.*
1884-85	18,000	1887-88	26,000
1885-86	22,000	1888-89	35,000
1886-87	18,000	1889-90	44,000

Of this total, above one third goes from Bombay, somewhat less

from Karachi, and almost all the rest from Bengal (Calcutta). Madras exports only a small amount, and that mainly to Ceylon. The total value of the exports in 1889-90 was Rs. 24,27,489. Out of the 44,000 tons exported in 1889-90, close upon 40,000 tons went to the United Kingdom, and 2,200 tons to Ceylon. Thus, the trade may be considered one almost entirely with the United Kingdom, and yet, despite this large influx of bones, it amounted, in 1885, to only about one fourth of the total amount of bones used annually in the United Kingdom.

For the statistics here given I am indebted to Mr. J. E. O'Conor, of the Finance Department, Government of India, and to Mr. H. Voss, of the Anglo-Continental Guano Works, London.

The collection of bones. The collectors of bones are mostly coolies of the *Chamar* caste. The bones are roughly broken with a hammer, conveyed to the nearest station, and there left for removal by train. Bones may be seen lying in heaps at a great number of the stations along the railway routes and waiting for removal to Calcutta, Bombay, and Karachi. Villages within a 10-mile radius of the line have been already cleared of any accumulated stores of bones, but collection of fresh bones goes on, although it does not as yet extend much beyond this limit. The collection of bones is thus a limited one, but, as railway facilities increase, so will it spread. In Bengal, where a damp, hot climate prevails, bones seldom lie long on the ground, but disappear within a couple of years; in the hot, dry plains of the North West, on the other hand, they get desiccated and bleached, and may thus last a long time and accumulate. Those accumulated stores, however, have now, for the most part, been already carried off.

What there is to [illegible] being utilised in [illegible]. **137.** I will now consider what stands in the way of bones being utilised in India for agricultural purposes.

(a) Caste prejudice. In the first place comes caste prejudice. The influence of this, however, will grad[illegible]
will not scruple [illegible]
so. In the busines[illegible]
the different sample[illegible] [illegible] a Brahmin.

(b) [illegible] value [illegible] known. Secondly, the value of bones for agricultural purposes has not been definitely shown as regards India. It seems hard to believe that there should so long have been this available source of manure, and yet that the *raiyat* everywhere should have been quite ignorant of its use. He utilises most of the materials that he has at hand, and even as regards those which prejudice has prevented him from using largely, night-soil, for instance, he is perfectly well aware of their fertilising value. But it is not so with regard to bones, nor have the experiments conducted on the Government Farms at Cawnpore and Nagpur succeeded in establishing the value of bones, nor in showing that it would pay the *raiyat* to collect and use them. I do not say that the enquiry is complete, but it is clear that the benefit of bone manures is not of the marked nature in India that it has been found to be in some parts of England. When

looking for a possible explanation my attention was drawn to analyses of Indian soils As I have pointed out in Chapter V (paragraph 65), these, as a rule, contain considerably higher percentages of phosphoric acid than most English soils do Now, phosphoric acid in the form of phosphate of lime is the chief ingredient of bones, and the one for which their use in agriculture is prized. Again, it is necessary to point out that bones, or even bone manures, are not of *universal* benefit even in England, on *some* lands, and in certain parts of the country, there is nothing that does so much good, in others they and the money paid for them are thrown away, and quite as good a result would be obtained by using the cheapest mineral superphosphate No practical farmer and no agricultural chemist has ever yet been able to determine exactly why or when this is the case, but it remains a fact that the application of bones has really to be made experimentally at first in order to see whether they do good, then, if they do, they generally pay well But each man has to get to know his land, and to learn by experience whether bones are good for it or not

Now let us take the practical difficulties apart from caste prejudice, and let us suppose for the moment that the value of bones in India had been proved The whole export is little more than one fourth of what the United Kingdom annually requires What would this amount to, therefore, if spread over the whole of a vast continent like India? It would not be much more than a drop in the ocean! (c) difficulty of collecting and keeping

Again, while it may pay a trading firm to send out collectors of bones, it does so only along rail-served tracts, and within a certain radius. We have to see how the *raiyat* would be affected The death of one of his cattle is, happily for him, not an every day occurrence, and when it does happen, it is only about 20 seers (40 lbs) of bones that are yielded. What is the *raiyat* to do with these? Is he to store them until another of his cattle dies, and so on, until enough are accumulated to make it worth his while to break them up and manure a field with them? Or is he to roam over the wastes and ravines and pick up single bones? If the use of bones is to be general, there would be others doing what he does, and how far would the bones go then? He would, again, find himself in competition with the paid agents of exporting firms, as soon as the extension of railways or the difficulty of getting a sufficient supply of bones near at hand had obliged the search to be made further abroad It must come to it, I think, that the most that the *raiyat* will do will be to throw the bones on to his *manure heap, even if he takes the trouble to do that*

Next, there is the difficulty of preparing bones for use Suppose the *raiyat* were to collect a sufficient supply and to keep them separate, how would he prepare them for use? Some kind of grinding is necessary, or the bones could not, so experience tells us, be used to advantage Unless bones be ground to a coarse meal, it is impossible to secure their proper (d) difficulty of preparing bones for use

distribution over the area to be manured, nor can the forces of nature so easily act on them and disseminate them throughout the soil as plant food. The old idea in England was, that bone was a capital manure because it *lasted* well, especially if after a number of years a piece of bone could still be found in a field this idea, has, very rightly, given place to the more scientific one, that a profitable return must be the one which is readily reaped in the crop and not merely stored up in the earth. Accordingly, the *fineness* of agricultural bone-meal is now insisted upon The *raiyat*, however, cannot afford to pay for a bone-mill, and he has no really available means for reducing the bones to a small size On two occasions I have seen bones being broken up by hand, this happened on the estate of Mr. Sabapathi Mudliar at Bellary, and at the Seebpore Experimental Farm, Calcutta At the former place women were employed in pounding the bone, and I was told they would make 100 lbs of bone into meal in a day. At Seebpore three men using a *dhenki*, or kind of lever hammer worked with the foot, made 20 seers (40 lbs) into meal in 5¼ hours. It is possible that if the value of bones be clearly shown, the *native cultivators* may begin to break up the bones that lie near at hand, *but that the practice will become a general one*, or that, if a general one, it will be capable of supplying the manurial requirements of the land to any great extent, I am inclined to doubt

Prospects of bone being an object of sale in India itself

It has been suggested that bone-mills might be started up country, and the bones be sold to the *raiyat* rather than sent for export, but then comes in the *raiyat's* difficulty, his want of capital He has seldom money to *pay* for manures, especially those the value of which he is not convinced of. And, in any case, the whole matter would be one of *market* considerations If there is a constant and increasing demand for bones, the price of which in Calcutta is now from Rs 40 to Rs 45 a ton (say 3*l* to 3*l* 15*s* a ton), they can only be kept in the country if those who are likely to use them are willing to pay as much as this or more, and where is the money to come from? A tea planter, or a coffee planter, perhaps, may find it worth his while to purchase bones, but it is only crops that yield a high return that will justify their use In such cases the planters generally have their own bone-crushing mills worked by steam, but, even in the midst of the indigo cultivation of Behar, I met planters who regularly collected and bagged bones for export, finding it more profitable to do so than to grind them up and use them on their land Railways will not do so much to distribute bones as to afford an outlet for them, in other words, they will facilitate the export

It is necessary to add one caution more,—as the demand for bones for export purposes increases, it will afford another inducement to the professional cattle stealer and the cattle-poisoner. Already the hide is an attraction, the flesh is rapidly becoming one also, if to these are superadded the

bones, more care will have to be taken in the future to protect the cattle of the country.

The whole question of the export of bones is, therefore, I hold, under existing circumstances, one purely of *market* considerations. The use of bones in India a matter of market considerations

138 The next subject, that of imported manures, which in an account of English agriculture would fill a most important place, may, so far as India is concerned, be very summarily dismissed If natural manures, such as bones, are not yet likely to be used, still less so are artificial manures Not only have no sources of the raw material been discovered which would pay for working, but the acid (sulphuric acid, or oil of vitriol) required for their manufacture, costs, at present, far too much Over and above would be the cost of carriage both of raw and manufactured material Once, again, the real *difficulty comes in, who is to pay for these? Only crops* giving a high return could possibly meet the outlay, and, owing to lowness of prices for produce, the tendency among planters towards economy in artificial manures has of late been marked The day is still distant, I believe, when artificial manures can be profitably used in India. Some great change, either in the cost of manufacture or in the condition of the agricultural classes must take place first A leading firm of chemical manure manufacturers told me, before I went out to India, the result of their efforts at introducing artificial manures into Russia and the East The only manure which they succeeded in getting into use in Russia was the cheapest mineral superphosphate, and then only in the enlightened Baltic Provinces, where the farmers were, for the most part, Germans While, however, there may be no immediate opening for artificial manures, it behoves those concerned in agricultural welfare to be on the watch for any developments that may take place For this reason I consider that the presence of an agricultural chemist would be of service in possibly discovering and in utilising fresh manurial sources Artificial manures

139 In connection with the extended use of manures, whether for employment in the country or for export, it is well to point out that the practice of adulteration has already been introduced This is the case with bone-meal For the purpose of competing against the well-known firm, Messrs Croft, Wells & Co, some of the native Hindu and Parsi merchants resorted to the mixing of bone meal with shell sand, lime, and similar cheap materials After inspecting Messrs Croft, Wells & Co's bone crushing mills at Thâna near Bombay, I was taken to the Mazagon Dock, Bombay, where, at and around the landing-stage, were several small establishments belonging to native merchants, and provided with bone-crushing machinery At some of these works I saw heaps of the shell sand, lime, etc, referred to, and of the bone-meal to which these were added I was enabled to get samples of the materials so used, and I give analyses of them in the Adulteration of manures. Bone-meal

Appendix.* They consisted, in one instance, of shell-sand, in a second, of burnt magnesian limestone, or substances akin to it Naturally, a business such as that which Messrs Croft, Wells & Co. carry on will have its imitators, and unfair dealings may be used in the competition In this way the reputation of Indian bone-meal as exported to England may be prejudiced, in the same way as that of Indian wheat has been. It is only, however, by purchasers insisting on receiving a definite guarantee of composition and purity, that security in transactions can be obtained.

Oil cakes

The adulteration of wheat and oil seeds will be considered later on, but, so far as my acquaintance went, bone meal was the only *manure* which I found to be adulterated. It is well known, however, that rape cake, when obtainable in England, is almost always mixed with a quantity of sand and earthy matter, although it is not clear where the actual admixture takes place

The presence of a chemist would be a means of detecting, and probably of checking, the practice of adulteration.

Points in which the native cultivator does not use the manurial facilities he has

140 Having now reviewed the manurial resources which are in more or less general use, I pass on to consider two main points in which the Indian cultivator does not make full use of what he has at hand These are, firstly, the non utilisation of night soil, secondly, the imperfect conservation of the ordinary manure from cattle

Importance of the utilisation of night soil

141. It is undoubtedly the case that a very great improvement might be effected in Indian agriculture if the system of utilising night-soil, sweepings, etc, were universal Of special importance does this become in a country which, as we have seen, is too poor to purchase artificial manures, or even to retain in it the bones now sent for export. Still more so when, as in the case of India, not the *crops* alone (such as wheat, linseed, and other oil seeds) are exported, but also the very *manures* which might be supplied in the refuse from the oil-seeds after the expression of the oil.

Mr Nicholson's opinion

Mr. Nicholson, speaking of Coimbatore, estimates that a population of 1,650,000 persons takes yearly from the soil, for food, 330,000 tons of grain, and a lot of other produce, of this but little is returned to the land Mr. Nicholson sums up his remarks in terms with which I thoroughly agree

"[illegible]

Sanitation of towns

I regard the spread of a good system of utilising human and household refuse, street sweepings, etc, on the land, as a most potent factor in the improvement of Indian agriculture, and having had among other duties to enquire into different schemes for town

* *See* Appendix M

sanitation, I must record my conviction that the *dry* system is the one best suited to Indian circumstances, and that any system which diverts from its proper destination, the land, that which has originally come from it, would be attended by loss to the cultivator and to the State, and would not be satisfactory from a sanitary point of view.

Prejudice is the bar to [illegible]

142. Prejudice is the great bar to the proper utilisation of night-soil. It is not [illegible] of the fields nearest [illegible] a tall crop, such as [illegible] indication that that particular field has come to its turn for receiving manure. On these fields the crops are manifestly better than the rest; what is wanted is, greater distribution of these fields The hope for improvement lies in the gradual breaking down of prejudice. That there are signs of this going on is evidenced by the fact that in certain towns, such as Farukhabad, Cawnpore, and Nagpur, the utilisation of night-soil has had an indigenous origin, and its spread has been due to other cultivators following the example set. It will be, on the one hand, by the force of example, and by the necessity of adopting the most remunerative methods, and, on the other hand, by the breaking down of prejudice through the spread of education, that, by degrees, the ready and natural means of replenishing the land by the use of night-soil will come into general use.

The hope for improvement

Instances where ni[illegible]ht soil is n[illegible]t used

143. In a great many towns and villages it is the practice to utilise the sweepings of the houses and streets, but not the night-soil.

I will now instance cases where the utilisation of night-soil has [illegible] and where it has resulted in very great agricultural [illegible] the increase of [illegible] to the State. These instances will afford evidence of that the capabilities that exist for the improvement of Indian agriculture *from within*.

To take, first, cases where the practice has been indigenous in origin.

Farukhabad.

The cultivation around Farukhabad is carried on almost entirely by *Kāchhis*. [illegible] collect and store the night-soil, and the [illegible]

(1) Cawnpore.

From Farukhabad Sir Edward Buck took some of the *Kāchhi* cultivators and induced them to settle at Cawnpore This they did and introduced their system of cultivation most successfully, so that the value of the land increased rapidly. Only a portion of the original settlement remains, as the land was required for the railway, but what is left retains still the name of "Buck Sahib's" village, and the rent is Rs 40 a *bigha* (⅝ths of an acre) The *Kāchhis* here spend as much as Rs 40 a *bigha* on the manure, and it is stored in trenches for one year before it is used.

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it realised Rs 31,001 The price varies with the demand, but is about Rs 2 per cartload of 700 lbs, say Rs 6 a ton

The urine and sullage water is not utilised as it is at Amritsar, but is allowed to flow into the river It would be well, I think, both for the sake of the land and also of the river, that a plan such as that employed at Amritsar should be tried Also, it is clear that the ready way in which the manure is disposed of at Amritsar must save much trouble and the expense of preparation into *poudrette*

(j) Cawnpore

I have mentioned (paragraph 75) the trenching of night-soil on salty land (*usar*) near Cawnpore Pits are dug 2 feet deep and only a light covering of earth is put over it, it is enough however, to prevent any objectionable smell Land thus trenched lets for Rs 45 per *bigha* (⅝ths of an acre) where there is water in addition, and for Rs 17 where there is no water

(k) Allahabad

[illegible] the Municipality, and poured [illegible] e top Two and a half acres are improved both manurially and [illegible] and open whereas beforehand it [illegible]

(l) Behar

I read that four Municipalities in Behar have begun to dispose of night-soil on land, and have realised profits by re letting the land In Gya the profit is Rs 100 to Rs 150 yearly, in Mozufferpore Rs 120, in Buxar, Rs 84

(m) Madura.

At Madura (Madras) night soil is mixed along with the town sweepings in the municipal refuse The latter costs about Rs 2½ a ton, and it is reported that the prejudice against it is passing off

[illegible]

Suggestions for village sanitation

144 At Ferozepore (Punjab) I saw in use the system of sanitation which I consider the best for village latrines It is the plan of having shifting screens or enclosures, made of bamboo, and within the enclosed area a shallow trench is dug, earth being thrown over at once by the attendant The screen is moved daily, and in this admirable way the land gets manured evenly and regularly Subsequently it is ploughed up, and crops (mainly vegetables) are grown

In regard to [illegible] that is worthy of attention was m[illegible] ricultural Association. The propo[illegible] -soil, etc, should be collected by village servants, hereditary or hired, and be sold to the villagers as manure, the proceeds going towards payment of the expenses of keeping the villages clean If there were some system of this kind inaugurated it would soon prove an agricultural benefit

Where night-soil is to be disposed of to the cultivators, the system in use at Amritsar seems to me to be the very best of all, especially as it provides for utilisation of sullage water, urine etc Still, it may not be possible to adopt it everywhere, and the Poona plan of making *poudrette* may sometimes be found the most practicable If night soil has to be trenched, I think that there is no necessity for the *deep* trenching so often employed. A depth of 1½ feet of earth, or even 1 foot, is not called for, earth is a capital absorbent and deodoriser of night soil, and a thin coat-

At Nawabgang also, near Cawnpore, I found *Chamar* cultivators using night-soil

(c) Nagpur

Another batch of *Kachhi* cultivators was transferred from Farukhabad to Nagpur, and, as mentioned in Chapter III (paragraph 27), not only did the continue their special kind of cultivation but the cultivators around (mostly *Kunbis*) were induced to follow their example, so that now the entire manure from the town is used

(d) Hoshiarpur

At Hoshiarpur (Punjab) night soil is used largely When I was there I was told of an action which the *sweepers* had even brought against the Municipality, to prevent their hereditary right to the disposal of the night soil being taken away from them

(e) Multan

Around Multan, street sweepings and night soil are used together

(f) Saharanpur.

Just outside Saharanpur I saw the market garden cultivation carried on by *Sánis* They use town refuse and night soil together, spending for sugar-cane as much as Rs 90 an acre in manure

(g) Meerut

Meerut is anothe[illegible] gardening, also by [illegible] in trenches leave it [illegible] price the cultivators [illegible] of 80 lbs each, which makes the price about Rs 4 a ton

The above are, so far as I have been able to separate them, examples wherein the utilisation of night soil has originated from the people themselves The instances that follow are those where an extended use of night-soil has been originated mainly by European enterprise.

Amritsar

At Amritsar there is a population of 150 000, involving a gross annual outlay of Rs 50 000 for scavengering, etc but no less an income than Rs 34 000 [illegible] cost [illegible] stem [illegible] r E [illegible] the market garden cultivation that has sprung up around the town, as the joint result of the use of night soil and the coming of the Bari-Doab canal is very remarkable. Land will let here for Rs 30 and Rs. 40 an acre in addition to canal water charges The cultivators are mainly *Arains* and *Kambos* (market-gardeners) It is only in the rains that night-soil has to be buried, at other times the cultivators come and take it away as soon as ever it is brought to the depôts on the borders of the town and so great is the demand that there is often quite a fight to get it! Dry earth is taken into the houses by the *sweepers* The cost of the manure is Rs 5 for a hundred donkey loads, each load being about 1 maund (80 lbs) Even the sullage water that passes [illegible]

the water flows

(i) Poona

Poona is another good instance of what can be done in an Agricultural direction by the use of night soil. Here the ashes, house sweepings etc, are collected, sifted, and burnt, the night soil is collected separately and put in layers with the ashes in pits 18 feet × 15 feet and one foot deep, [illegible] whole [illegible] which [illegible] days [illegible] re is a [illegible]

the town and preparing the manure is met by the sale of the latter, in 1889 90

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smell I
to form
below, consequently it does not amalgamate well with the earth. If, on the other hand, a depth of only two or three inches of night soil be used it is much more quickly incorporated with the soil, and the land is earlier ready for sowing, or for trenching again

General neglect of use of night-soil.

145 Although the foregoing cases of the utilisation of night-soil have been named, they are exceptional, and there is still a general neglect, throughout the country, of this useful source of manure one doubly useful because it is at hand and has not to be purchased

Throughout Bengal, for example, night-soil is, as a rule, not used at all, in Surat (Bombay) and Ahmedabad town sweepings are regularly used, but not night soil Similarly, in Madras I found that at Shiyali Salem, and Avenashi, only the sweepings were used In some places there was no one to collect the night-soil, in others, there was a general idea that a crop would not grow with it, though the experiment had never been tried in others again, no one would touch the material In brief, in almost all the villages which I went to, and in whatever Presidency, as soon as I asked the question whether they made use of the night-soil, the cultivators shrugged their shoulders and turned away

But I believe that, in time, a change will come, and, if reasonable arrangements be made, and the example given elsewhere be *wisely enforced, there will undoubtedly follow distinct* agricultural improvement.

Imperfect conservation of cattle-manure

146 The second point in which the cultivator does not make full use of what he has at hand is in the conservation of the ordi-

but it results in little more than a deeper hollow being made, and serves to expose a fresh surface for the urine to sink into. The value of the urine is, I am sure, not only not fully appreciated, but is actually unknown to a very large number of the cultivators. Did they know its value they might do something more to save it.

I give here an analysis of a sample of Urine taken direct from Indian working bullocks, at the same time and under the same circumstances as the sample of dung, the Analysis (A) of which is given in paragraph 121 of this chapter [Table VIII]. For the sake of comparison I give a standard analysis of cows' urine (English).*

TABLE X

Analyses of urine

ANALYSES OF URINE from INDIAN BULLOCKS and ENGLISH COWS

—	F Urine of Bullocks (Indian)	G Cows Urine (English)
Water and evaporable matters	90 62	91 50
* Solid residue	9 38	6 50
	100 00	100 00
* including mineral matter (ash) †	1 74	
† containing—		
Sand	01	
Lime	·08	
Magnesia	67	
Potash	643	1 60
Soda	02	
Phosphoric acid	022	
Total nitrogen	1 168	90
equal to ammonia	1 418	1 09

TABLE XI

Analyses of leaves used for litter.

ANALYSES of LEAVES used in MYSORE for LITTER

—	H	J
Moisture	10·73	10·72
* Organic matter	78·44	84 68
† Mineral matter (ash)	10·83	4 60
	100·00	100 00
† containing—		
Phosphate of lime	1 07	23
Silica	3 63	·04
Potash	·73	1·09
* containing nitrogen	·91	1 18
equal to ammonia	1 10	1 43

REFERENCE.—*Analysis G*—Johnston and Cameron's Elements of Agricultural Chemistry and Geology page 321

* *See* also Appendix G.

The high value of urine

Computing the two analyses of urine, the Indian sample is not inferior to the English, and contains even more nitrogen Urine contains the greater part of the potash of the total voidings, and, though I do not know the average quantity of urine yielded by cattle in India, it has been found in England that the total amount of nitrogen voided in the urine is from three to four times the quantity contained in the solid excrements Seeing, therefore, that the urine of animals is richer in fertilising matters than the solid excrements, the loss involved by letting the urine go to waste must be very large The answer generally given by cultivators when I asked them why no litter was used, was, "We have not enough fodder for our cattle How shall we give them any litter?" And yet this is not a real answer, for, when I turned to the manure heap, I almost invariably found in it stalks and straw and leaves, all of which would have done to use as litter. These stalks were thrown in anyhow, so, too, the solid manure, but there was no attempt to make really good farmyard manure out of it, or to let the dung, as it fermented, break down and decompose the stalks and straw and form a uniform mass Each material was left to itself—the stalks to remain as they were, hard and desiccated, the manure to get dry and to lose part of its value by exposure to the fierce sun during the hot season, or to the heavy rain in the wet season Had these stalks, straw, etc, been put under the cattle, and been trampled down by them, it would have served to retain a not inconsiderable portion of the urine and would have made a more uniform material, and one which would have all rotted together aferwards, and formed good farmyard manure. I do not say there is abundance of material for litter in all cases, but there is certainly a great deal that might be utilised Leaves, for instance, though collected for parching grain, are neglected for litter Again, if loose earth were sprinkled on the floor, to make up the deficiency of litter, and if this were to be periodically removed, much of the urine could be collected Waste and coarse grass, shrubs, weeds, leaves, and rubbish of almost any kind would serve for the purpose, and I have often thought that if I could but spread the so called manure heap under the cattle again, I could double its value

Litter not used

How manure might be better preserved

Where the cattle are better cared for, earth-nut, gingelly cake, gram, and other foods having high manurial values are given to them frequently, but it is not borne in mind that with these more concentrated foods it is only about one tenth of the nitrogenous and mineral constituents of the foods that actually goes *on to the body of the animal and repairs its waste, but that* nearly nine tenths remain in the solid and liquid droppings It is the knowledge of this fact which has made English farmers careful to preserve the manure of cake-fed cattle, and to keep their stock in covered yards instead of in the open.

Another frequent source of loss is, that the manure is often put, not in pits, but in loose heaps into which sun and rain can easily penetrate Even when pits occur, they are often not much more than holes dug in the ground If the bottom of the pit were well rammed down and the sides beaten firmly, or, where

possible, plastered over with clay and allowed to harden, much loss would be saved The manure, once in the pit, ought to be turned over occasionally, even in India, so as to get the drier portions mixed with the moister, and to make the mass rot evenly together When the rains come, there is no difficulty in covering the pits with earth, and if the manure were well made and less like the contents of a rubbish heap, less space would be taken up, and it would well repay to cover it with earth as suggested.

In Appendix F I have given an analysis of a sample of the liquid which was draining away from a manure heap at Bartchinhulla, Munjerabad, Mysore, and alongside I have put the analysis of a similar sample from a manure heap in England. There figures show that the drainings from the Indian manure heap are slightly richer, both in solid matters (including potash and phosphoric acid), than those in the English sample, and that they contain considerably more nitrogen It is evident, therefore, that allowing the drainings to go to waste is productive of considerable loss in India, equally as it has been found to be the case in England. Drainings from manure heaps.

147. One objection made to littering cattle is, that if they were kept in sheds with litter under them they would be pestered with *ticks* and flies, and that on this account cattle have to be occasionally tethered out in the open fields Of course, when flies or *ticks* are particularly troublesome, the cattle can be tethered outside, if necessary, just the same, but it is simply the general principle that I am advocating, one which, if adopted, would result, I am sure, in much saving Objections to use of litter

Another objection is the one which the English farmer made when covered yards were first introduced, *viz*, that the cattle would be unhealthy, however, in England this has not been found to be the case, and, even as it now is, Indian cattle are often tied up in sheds, so I do not believe for a moment that the sprinkling of a small amount of litter, coarse grass, etc, supplemented by loose earth, would have any other effect than to make the sheds smell very much sweeter and cause a very important saving in manure The popular idea in India, that cattle kept in sheds with litter put under them would fall ill, has been disproved by a 15 years' experience at the Saidapet Farm, Madras Mr. Benson adds, from his own observations in the Presidency, that he has never heard of a case where any harm has resulted to the cattle from their being littered in sheds

To my mind, a much more potent reason given for the non-adoption of the system is found in the answer which a *raiyat* gave me at Avenashi (Coimbatore) "It is hard enough to get "sheds for ourselves," he said, "how shall we get them for "our cattle?"

148 It is clear to me from what I have seen all over the country, and also from the writings of others, that manure is Instances of manure being badly kept.

not well kept, and that there is great room for improvement in this particular.

(a) Punjab

A little beyond Multan I saw heaps of dung scattered over the fields, they had been left out in this way for over a month

ure heaps was thrown a quantity
have done over and over again for
sold for the local trade of pottery-
l for manure upon the coming of

Mr E B Francis, of Ferozepore, writes to me —

"The most important question in the improvement of our agriculture is "to improve the collection and storage of manure, which would at the sa e "time be a measure of sanitation"

(b) North West Provinces

It is a frequent practice at Cawnpore to spread the manure out on the fields early, and to leave it in heaps until the rain comes By doing this considerable loss is incurred, the manure ought to be spread out at once over the ground, and then the loss would not occur

Mr Moens, in the Bareilly Settlement Report, says —

"There are two points on which our agriculturists need instruction— "(1) growing green crops for cattle, (2) the proper management of their "manure"

(c) Bengal

In Tirhoot I saw near Bara heaps of manure lying in fields where they had been exposed for several weeks and were fast losing their goodness

The following extracts are taken from Bengal Reports :—

Palamau —"Manure is kept on the bare ground, and a great deal is "wasted"

Burdwan.—"Manure heaps are not well kept, and the urine is wasted. "Sometimes the heap is very carelessly managed and let to get too dry No "litter is used, and the urine is allowed to sink into the mud floor of the "cow shed

Dacca —"Instances are not wanting of heaps of rich fed cattle manure "wasted"

(d) Madras

In only a few places in Madras did I find any attention paid to the preservation of manure At Avenashi no litter of any kind was used, and the cultivators seemed e l as litter
On the manure heap a c but it was
not rotted at all and All this
time the bullocks were ing wasted
on the hard bare grou own under
the cattle the urine m only right
to add here, that the *raiyats* expressed themselves as very ready to receive instruction from anyone who would impart it to them

At Shivali and Madura I saw no litter used, except in one instance

Mr Benson, writing of Kurnool, remarks on the bad way in which manure is kept

Of Pallachi, in the Coimbatore district, Mr Nicholson says —

"The improvidence of the *raiyat* is here exhibited in his reckless waste "of manure, whether animal or otherwise, which lies everywhere around the "villages"

(e) Government Experimental Farms

Even at the Government Experimental Farms, although in some cases care was taken to store the manure better than the *raiyats* did, I found there was still great room for improvement

I must make an exception in the case of the Saidapet Farm, Madras, for, here, littering of cattle was carefully done But at one of the Bombay Farms (Poona) the urine was allowed to trickle down an open drain, merely

cut in the earth, but not piped in any way and was supposed to flow on to a manure heap at the other side of the farm buildings and situated a considerable distance off. The consequence was, that, so far as I could see, the urine was all absorbed in the earth before it reached the heap, except,

[illegible]

over to. I believe that a great deal might be done by showing the usefulness of leaves for litter. When I was in Mysore I saw them wherever being used by coffee planters as litter in covered sheds for [illegible] of cattle manure, and it is quite feasible to extend the [illegible] of these to many other parts. A slight sprinkling of fresh [illegible] the surface every now and then is all that is necessary, [illegible] are *Palmer* layers get trodden and matted well together, [illegible] lots of manure. In Table XI, paragraph 146, I have [illegible] against [illegible] of leaves collected for this purpose, a large [illegible] been mixed carefully and subdivided repeatedly to [illegible] it, that, samples. A comparison of these analyses with [illegible] to be stoyard manure (Table VIII, paragraph 121) will show [illegible] lost, and more nitrogen and about the same amount of potash [illegible] properly as in the dung, the large proportion of vegetable [illegible] *made* matter must also exercise decided benefit. In one in-[illegible], rich [illegible] of phosphate of lime is as much in the leaves as [illegible] not yet yard manure. The two analyses of leaves show con-[illegible] variation in the amount of mineral matter in each, this [illegible] and [illegible], from different kinds of leaves being used. The [illegible] values of different kinds of leaves for manurial purposes [illegible] be worked out. The leaves of the *Jack-fruit* tree [illegible] *integrifolia*) formed a large proportion of the sample [illegible]. The leaves analysed were those collected on Mr. R [illegible] Mysore, and were similar to those he [illegible] littering his bullocks. In some parts, [illegible] coast, it is the practice to collect and use leaves for manure.

150. If I have spoken of manure being badly kept, it is only right to mention a few instances where it is better looked after — Instances of manure being well preserved.

The Saidapet Farm at Madras has already been spoken of as one instance.

On the Eastern side of Rawal Pindi it is the practice to impregnate stable litter with urine before throwing it on the manure heap.

In Tinnevelly, earth is often thrown over manure heaps before these are used for the cotton crop.

Littering of cattle by the coffee planters in Mysore has been referred to.

At Shiyali Mr S. Sabanayagam Mudliar makes pits and clamps the manure closely together, in Gujarát (Bombay) manure is kept

in pits and not in heaps; at Nadiad Mr. Becherdas Viharidas Desai has a very large masonry pit in which manure is stored, and from which his tenants (those from whom he takes a share of the produce) are supplied. It was at Nadiad, too, that I witnessed perhaps the most careful method of conservation of manure to be found anywhere in India. At the time of my visit, the metho
was unfortunately threatened with abolition through the action o
the Sanitary Authority. The practice in the town was, to keep th
cattle in sheds within the compounds; the ground sloped away in
one corner close at hand, where a pit was carefully dug and ...e
tered, a channel was cut, leading from where the cows stood
along this the urine was led into the pit (a distance of only on the
yards) In this way the urine was soaked up and absorb ...g this
solid excrements, ashes, and house-sweepings. As fres ...ace over
was dropped, it was added to the heap by plastering it
surface In this way an almost solid block of first-ra ... instruction —
including the urine, was formed, and the surface ge ... ment of their
hard and dry, there was little or no smell, nor anything

Necessity of teaching the ryot a better practice

151. The instances of manure being properly ... ds where they
however, very rare, and, broadly speaking, it may ... oodness
the Native *does not know the best way of making* ...
nor of preserving it when he has it. At the sam ... great deal is
believe that if he were shown how to do it, and were to
that the practice is better than his present one, he w ... rine is wasted.
and would litter his cattle. ... too dry. No
... l floor of the

The work of Government Experimental Farms.

A great opportunity is given to Government E ... attle-manure
Farms to show how this can be done. If this matter w
taken up simultaneously at all Experimental Farm ... paid to the
cultivator were shown (as I am sure he would be) ... s used, and
manure could be made, and better crops be grown as theed as litter.
saving the urine and storing the whole carefully, it wo ... but it was
more good than experimenting with artificial manures ... All this
altogether beyond the reach of the *raiyat*. ... g wasted
... nder

Village sanitation

152. My enquiries into the subject of the better conservation of cattle-manure brought me into contact with points concerning village sanitation. To one of these, as distinctly affecting agriculture, I must refer, more especially as the extended *application* of the sanitary rules is contemplated. This I c ... illustra
the instance of Nadiad, in Gujarát (Bombay) ... h I ref
in paragraph 150. I there described the ca ... od by
the cultivators preserved the solid and liqui ... of
cattle, keeping them, as well as the ashes, h ... gs,
such a way that there was *the minimum of*
at the same time no smell or oth ... ion.

Hardship of the sanitary rules illustrated in the case of Nadiad.

duced. Notwithstanding the ... sed
sanitary authorities, in their a ... ot
the manure heaps, and had fo ... ho
the precincts of the dwelling ... onse
that when I visited Nadiad ... 390,
being closely-packed heaps ... ited

e compounds, the urine being absorbed before it had had time) decompose, I found, lying along the roadsides, or in the lanes, r by the hedge sides, numerous small loosely-packed unfermented heaps of fresh manure and rubbish, on which the rain beat down, washing out the goodness, and rendering it cold and unfermentable. Women might be seen carrying out in baskets on their heads mere handfuls of manure, they having frequently to go a considerable distance several times a day Within the compounds it was even worse, for the cattle being still kept there, the urine, now no longer absorbed nor allowed to collect in the pit, flowed over the ground, and, mingling with the rain water, ran into the

[illegible]

the usei

leaves b

the mak of things infinitely worse than before. But it is the this agricultural loss to which I wish particularly to refer The people [illegible] terly of having to convey the town every day, they say that ngs to let their women carry the had to pay for hired labourers quantity hurt; that, when the heaps were put out, they were constantly get [illegible] o be stolen, that the manure was not well made, the urine that of [illegible] st, and the heap much spoilt by the rain, so that it never that there is properly. To test them, I asked to see what they called in the leave *ade* manure, and soon I was shown some well-rotted, nearly (organic) m rich manure, obtained, no doubt, from a manure pit which stance the t yet been removed. The quality of this was such as to in the farm ce me that these people, at least, knew what good manure a deal er nd how to make it In a part like this, where a magnificent arising do ation was in a very great measure the result of the careful rela ive va rvation of manure, it seemed to me a great mistake that the [illegible] only to produce a state sanitary light, and one is absurd to take such emain within the com- and the manure heaps making the roadsides objectionable Either the *Patidars* ought to be allowed to follow their economical and unobjectionable practice, or the cattle ought not to be allowed to stand at all within the compounds The reason stated for the action of the authorities was, that human ordure was also put on the heaps in the pits, and a rule was made to compel the people to resort to the latrines outside the village Even if a little ordure did so go, it was of small consequence and showed a sense of economy, and, besides, whatever sanitary rules may be made, I do not believe that they will ever succeed in compelling the women to go out at night into the fields where the latrines are The people of Nadiad are very healthy, and epidemics are much more frequent in the towns than in these rural districts It was pointed out also that, while the presence of the manure heaps was considered by the sanitary authorities to be highly dangerous, it was the practice everywhere to plaster the walls and floors of houses with cow-dung, and yet no

9

one got ill from it Fully one-third of the entire population of Nadiad were cultivators.*

When I was in the Central Provinces I found that similar rules were being enforced on account of the fear of cholera Nevertheless, the cattle were still allowed to be tied up at the houses, although the manure had to be carried outside the villages Here, however, the manure heaps were not kept with the same care as was exercised at Nadiad

Closing over of drinking wells

I might mention in this connection the desirability of covering over, both in towns and in villages, all wells which are used solely for drinking purposes

In view of the contemplated extension of the application of sanitary rules, I have gone into these matters at considerable length, as I think that attention should be paid to them

Wider distribution of dwellings and wells over the land advisable

153 There is one way in which the manure supply, both of cattle-manure and of night-soil could be used to better advantage, but it is hardly a feasible plan now, I fear I have remarked upon the appearance of a North-West village, the habitations crowded together the wells and the best cultivation and the most highly manured land lying close around the village site This, doubtless, has arisen out of the experience of the past, owing to the necessity of combination for self-protection against the raids of marauders Undoubtedly, however, if the habitations could now be more scattered over the land, and not be huddled together on one spot, the manure would be more widely distributed also, and probably not be so much wasted, the wells also would be dotted about and not clustered together Captain Chapman told me that when he came into possession of his property at Shahpore, in Oudh, one of the first things he did was to dig wells, not around the village site but distributed over different parts of the estate The consequence was, that when new settlers came, they fixed their dwellings where the wells were, and thus the manure from their cattle was distributed over a wider area and was not concentrated around the dwellings, leaving the outlying parts unmanured

Could the habitations be more scattered, and tho wells, too, the land would certainly be better manured

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* Since writing the above I have heard that the Collector of Nadlad has recommended that the inhabitants be allowed to keep their manure heaps in the town as before provided that each man makes a pit with brick sides and that the manure be removed to the fields as soon as the it is full

CONCLUSIONS

CONCLUSIONS

154 Whilst a few soils, such as those of silt-renewed tracts, the black cotton-soil, and newly-reclaimed or virgin land, may not require manure, it may be said of the greater part of India that the necessity for using manure is enormous, and the supply of it is notoriously inadequate Water and manure are interdependent, and, just as the former has been and is still being provided for, so must attention be given to the supply of manure. These two factors, water and manure, constitute the *raiyat's* great needs, and in their supply consists, very largely, the Improvement of Indian agriculture It has been shown in this chapter that, under existing circumstances, the manurial supplies in use are not sufficient to replace the crops that are taken off the land, further, that the increasing tendency to export both crops and manures must cause a deterioration of the soil.

In considering the various sources of manure, it has been pointed out that, with the exception of cattle manure, the amount and use of them is most limited

Practically, therefore, everything centres in cattle-manure, and the question of how to use it to better advantage

There are two main causes which prevent manure from being properly utilised. The first is, that it is burnt as fuel because there is a deficient supply of wood, the second is, that it is not properly made, inasmuch as the urine is altogether wasted, and the manure is badly kept. The second of these two causes may be gradually removed by the spread of agricultural instruction, and by the example of Government Farms and Estates. The first cause, however, is one that cannot be removed except by the taking of bold measures by Government, such as those taken in introducing canals and in carrying them throughout the country Government cannot directly provide manure for the land, but what they can do is, to provide wood to take the place of cow-dung as fuel, and so to liberate the latter for its proper use upon the land. In short, Government must now turn to supplying wood for agricultural purposes just as they have supplied and are supplying water.

The situation has been sketched out in Chapter V (paragraph 51), when dealing with the question of exhaustion of soil A rapidly-increasing population creates a greater demand upon the

soil and upon the food crops which it bears Could the produce be increased even by one or two bushels per acre, as Sir James Caird estimates, the difficulty of population would be met, but without more manure the soil cannot do it, and the export both of crops and manures is *removing* instead of *adding* to its fertility Meantime the increase of water facilities, through Government aid, calls for the use of more manure, but the latter is for the greater part wasted because the supply of wood for use as fuel is inadequate What is the position of Government in the matter? For practical purposes Government are in the place of a landlord, and as such it is their duty to look after their property, and to see that it is kept up, and not be allowed to become impoverished The present system is one of gradual soil-exhaustion, which must end in a decline, slow it may be, but still a decline of fertility and of productive power It behoves Government, therefore, for their own sake, to take this matter into serious consideration, and, while there is yet time, to push forward active steps for preventing the decline in the value of their property Unless this situation be faced, Government must be distinctly prepared to see the land bring in a diminished revenue, and to find the people less able to live upon the land Nor must the bearing upon the question of Famine be ignored

Mr Nicholson has pointed out that in times of serious drought manured land is able to yield at least something, or even a moderate crop, whilst unmanured land may produce absolutely nothing. The existence of some crop, instead of total failure may make all the difference between famine and no famine

Lastly, there is the consideration that if more manure be supplied, the land will become more fertile, and be capable of returning an increased revenue to the State It therefore becomes, I maintain, the duty of Government, both to themselves and to the people, to supply manure to the land In this, now, must rest practically the Improvement of agriculture. Of what benefit will it be to cover the country with Agricultural Schools, and to teach better methods unless the one great want of the cultivator be met, *viz*, more Manure? Of what use will it be to demonstrate at Experimental Farms the value of manure, and how to preserve it, when the cultivator has to burn it because he has nothing else for fuel?

The one way in which alone this question of paramount importance can be met is by supplying more *Wood*, and thus setting

free the manure for use on the land. I shall deal in the next chapter with the exact way in which wood might be supplied, but I may say here that it is in this connection mainly that I advocate the establishment of "Fuel and Fodder Reserves"

To adopt the method followed in my earlier chapters, of summarising possible improvements in agriculture—it has been seen that considerable differences exist in agricultural practice according as the facilities for manure supply are greater or less. Improvement in agriculture will take place through the modification of these differences This cannot be effected directly by the people to any great extent, although, here and there, as with the *Kachhi* cultivation, example will tell. Government will be able to assist in the work by the spread of Agricultural Education Education will have a powerful influence in breaking down prejudice, and, by it, the better practices and their advantages will be made known.

But the work of Government does not stop here, *positive* measures, too, must be taken First and foremost, Government must supply wood for agricultural purposes, to take the place of the cow-dung at present burnt. Then, Agricultural Departments must, by means of an organised system of *agricultural enquiry*, ascertain the manurial facilities and needs of each part of the country, they must acquaint themselves with the practice of the best parts, and transfer it, when possible, to others, they must ascertain and demonstrate at Experimental Farms the value of various manures, and, in especial, the benefit of littering cattle and the better preservation of manure It is evident that in this work advantage will have to be taken, not only of a knowledge of indigenous practice, but also of Western science and experience. In this connection I would urge, as most desirable, the appointment of an Agricultural Chemist, who may render much assistance in utilising existing manurial sources, in demonstrating their use and value, in possibly discovering new manurial resources, and in solving various questions bearing on the relation of soils, crops, and manures.

RECOMMENDATIONS

RECOMMENDATIONS

155 I advocate,—

The establishment of "Fuel and Fodder Reserves," for the primary purpose of supplying wood to take the place of cow-dung as fuel.

The inauguration of a system of Agricultural Enquiry, to ascertain the manurial facilities and requirements of each part of the country.

The spread of Agricultural Education, to assist in teaching the value of better practices, and to break down prejudice.

The employment of Experimental Farms, for the purpose of showing how manurial resources can be best used and conserved, and for demonstrating the value of, and extending, the better practices of other parts.

The employment of an Agricultural Chemist, to assist in utilising existing manurial resources to best purpose, in discovering fresh ones, and in the solution of agricultural problems

CHAPTER VIII.

CHAPTER VIII

WOOD.

Wood.

156 From the last chapter, in which the manurial resources of India were considered, I pass now to discuss the wood supply of the country, and how it may be increased, primarily with the view of setting free more manure for the land by the substitution of wood for cow-dung as fuel.

In order to understand how agricultural ends in the matter of wood supply are to be best served, it is necessary to briefly review the policy which, in the early days of the Forest Department, was adopted in regard to forests and other supplies of wood, and also the changes which have been called for in more recent times.

Early policy of Forest Administration

157. At the time of its creation, about 1866, the Forest Department found the forests of the country fast disappearing before the spread of cultivation, and before the reckless destruction carried on by the people. Agricultural resources were vanishing, and the climate was, not improbably, being affected injuriously None too soon did the Forest Department step in to prevent the entire deforestation of the country, which would most certainly have taken place As the demand for cultivation spread, so would the forests have disappeared before the plough, had not a strong hand been interposed to save what was still remaining.

The people, left to themselves, have never been able to manage forests properly, nor to understand how forests may be conserved and utilised to the best advantage Their practice had been simply to cut and clear the forest to make room for cultivation, and, as soon as the virgin soil was spent, they pushed on, broke up fresh land and cleared more forest And this, if allowed, they would still do, thinking only of the immediate present, and not of the future

Good work done by Forest Department.

But the Forest Department, by its intervention, has stopped in a great measure the work of destruction, and has not only brought in a large, and ensured a continuous, revenue to Government, but it has laid the foundations of a system which, if properly directed, may be made to conduce greatly to the agricultural prosperity of India But when it began its work its chief duties were the preservation and development of large timber forests, such as the teak forests of Lower Burma, the *sál* forests of Oudh, and the *deodar* forests of the Himalayas, or the forests of the Western Ghats Its objects were in no sense agricultural, and its success was gauged mainly by fiscal considerations, the Department was to be a revenue-paying one. Indeed, we may go so far as to say that its interests were *opposed* to agriculture, and its intent was rather to *exclude* agriculture than to admit it to participation

Its success measured by direct financial returns.

in the benefits The chief reason for this was, that the admission of grazing into the forests would have destroyed the young seedlings, and have rendered the maintenance of the forests by natural reproduction impossible So far as the original design went the Forest Department deserves full recognition of the admirable work which it has done in saving to the country the forests now under its care, but which, if left to the people, would have been ruthlessly destroyed

Causes of a change of policy

158 At that time, however, these large timber forests were not in contact with important tracts of cultivation, but were, for the most part, situated on hills and mountain ranges only occasionally bordering on cultivation, and that of a sparse and backward kind, often carried on by half-wild tribes As the population increased, and the pressure on the land called for extension of the cultivated area, so the latter spread to the borders of the forests. Again, of recent years, there has been a feeling that the forests and other wooded tracts ought to be made to serve the interests of agriculture more directly than they have done in the past, and that areas should be reserved and fresh ones be created in the midst of the cultivated land, and not merely on hills and mountain ranges The Governments of India, Bombay, and Madras have been urging their respective Forest Departments in this direction, and have endeavoured to extend the influence of the forests from the remoter hills to the cultivated plains In this way the policy of the Forest Department has been undergoing a change, in order to meet the altered conditions of agriculture The old traditions which animated its officers, *viz.*, that the sole aims of a forester were to grow big timber and to show a large revenue, are wearing off, and, whereas considerable prejudice existed in the past against the Department, by reason of its being opposed to agriculture, a feeling is now growing, among the more enlightened of its officers at least, that one great object should be to directly *serve* agricultural interests. It is this altered policy that I wish to support, and to show, if possible, the need of giving fuller scope to the usefulness of the Department

Agricultural requirements in respect of wood

159. The requirements of the agriculturist in respect of wood are small timber for house building, wood for making implements, and firewood, the last named principally to take the place of the cow dung which, though the most valuable manure at the *raiyat's* disposal, is, nevertheless, generally burnt as fuel in default of wood.

The paramount importance of supplying wood to replace dung as fuel

160. In the last chapter, after reviewing the various sources of manure supply, we saw that they were very limited in number, and that the only material available in any quantity was the ordinary cattle-dung Further, we found that, wherever wood was sufficiently abundant, dung was used for the land and it was not burnt, but that where wood was deficient, manure was burnt in the absence of any other source of fuel,

and that the land was thus deprived of it The dependence of the soil for its fertility upon the supply of water and of manure was also instanced. The conclusion was, accordingly, drawn that the supply of wood to serve as fuel forms one of the most important factors in maintaining the fertility of the soil, or, in other words, the prosperity of agriculture. I can hardly put this too strongly, for it is *the one* practical measure on which I place the most importance, it is that which calls for the most urgent attention, and from which the greatest benefits may be expected to follow I make, in my Report, other recommendations and suggestions, it is true, but I consider them *minor* ones compared with this Let us once more review the position A country exporting manures as well as crops, not utilising even the night-soil, and then burning the cattle dung because fuel is scarce, an ever increasing population, and a greater demand on the land to supply more and larger crops, these latter depending on more manure being available What more ready plan than to supply wood as fuel in order to save the manure for the land? In the substitution of wood for cow-dung no question of *caste* prejudice is involved, such as is the case in the use of bones or of night-soil It is a measure which the people would adopt, and have adopted, on their own account, wherever it has been possible Further, the improvement thus to be effected is one which proceeds upon the right lines, *viz* the improvement of Indian Agriculture from *within* rather than from *without*

The importance of this to Government

I therefore do not hesitate to say that, just as Government foresaw the difficulties of the people in supplying themselves with water, and so provided it for them, so must attention be now turned to the difficulties of the people in the matter of fuel, and, seeing how impossible it is for them to provide it for themselves, Government must do this for them too It is not in the interests of the people alone that I would urge this, for, having fully discussed all other ways of increasing the manure supply, it is clear that this is *the one way* in which it can be effected, and, if not effected, sooner or later the land must fall off in productive power, and the revenue derived therefrom by the State must decline too Accordingly, I regard the provision of fuel as the most potent means of maintaining prosperity, not alone to the cultivators, but to the State itself, and as a measure which the latter, *in its own interests*, should take up immediately If wood could be made to take the place of dung for fuel we should soon come to realise that more wood means more manure, that more manure means more crops, and more crops an increasing revenue to the State, whilst, to the cultivator, it implies more fodder, better cattle, and more manure again to ensure the future fertility of the soil

Previous expressions of this view

161. I do not take to myself credit for more than emphasising what others have already pointed out on this subject As much as 17 years ago Mr R H Elliot, writing in the "Times," urged the necessity of "Fuel Reserves" for India, and much that he then said has since proved to be true. The same views have

been urged by others, but there is call now for more definite action than there has been in the past What has been done so far, whilst not without benefit to agriculture, has, to my mind, taken mainly the form of supplying wood for the requirements of large towns and railways. Although agriculture has been indirectly helped by the smaller amount of dung burnt in consequence yet I think that hardly enough importance has been attached to the bearing of the wood supply upon the fertility of the soil, and to the need of supplying firewood to villages as well as to towns

Other advantages of tree growing

Influence on climate

162. The influence of an extended growth of wood upon the climate has been fully dealt with in paragraph 38 of Chapter IV, and has been referred to as affording a possible, though perhaps only local, amelioration of the severities of climate.

Protection from winds and sun

There is another feature about tree growing which must not be forgotten, *viz*, the shelter and protection afforded from the burning sun, and also from the violent winds Mr. Nicholson points out that many tracts in the Coimbatore district are exposed to severe winds. He says —

Dharapuram District —' Hedges and belts of trees would be peculiarly ' useful in this wind swept tract.

Udamalpet —' It is the most *open taluk* in the district, having few " hedges and very few trees, hence the winds of the south west monsoon are "severely felt

Many parts of Mysore suffer greatly from damage by wind On the North-West frontier the presence of trees is indispensable to the growing of grass

Supply of leaves

The advantages of tree growing in connection with the supply of leaves for litter and for manure have been spoken of in Chapter VII (*see* paragraph 149), and to this may be added the provision of food afforded both to men and cattle in time of famine, if suitable kinds of trees be grown.

Famine food

What Governments have already done in this direction

163 Whilst laying particular stress, as I have done, on the need for an extended wood supply, and mainly for the purpose of providing fuel, it would be wrong to ignore what the respective Governments of India, Bombay, and Madras have done, or, at least, have urged on their Forest Departments the necessity for doing Without going into particulars, I would indicate the general lines that have been taken

Sir D Brandis work

It was Dr (subsequently Sir Dietrich) Brandis, the real founder of the existing Imperial Forest Department, who gave the great impulse to the growth of what may be termed "Agricultural Forest." It was he who clearly saw the line which the Forest policy of the future would have to take, and who did his best to guide it in this direction Already in 1878, at his suggestion, tracts had been taken up in Ajmere-Merwara, a little territory under direct Imperial control, and thus available for the purpose. This will be explained more in detail later, but it may be said here thatt he results were very satisfactory, and Sir D Brandis wrote '—

' It may be pointed out that in all except the most arid tracts, or where "denudation is complete and of long standing, mere protection aided by

"sowing and planting in suitable places, will gradually clothe grounds with "trees and shrubs.

Sir D Brandis, at the close of his Indian career, went himself to Madras to assist the Madras Government in framing their policy of "Agricultural Forests," and largely to his efforts it is due that in Madras so much has been done to make the Forest Department serve agricultural interests

The Famine Commissioners showed that they were alive to the way in which the forests might assist agriculture They said in their Report — Recommendations of Famine Commission

"So far as any immediate advantage is to be sought from "the extension of forest in respect to protection against "drought it will, in our opinion be mainly in the direction "of the judicious enclosure and protection of tracts . . . "from which improved and more certain pasture may be "secured for the cattle of the vicinity, a supply of fire-"wood secured which may lead to a more general utilisation "of animal manure for agriculture, and a possible addition "made to the power of the subsoil to retain its moisture, and "to the prospect of maintaining the supply of water in the "wells"

The Government of India, in following up the recommendations of the Famine Commission, issued, in March 1883, a Resolution calling attention to the growing decrease in the area of grazing land and wooded tracts in many parts, notably the Punjab, the North-West Provinces, and the Central Provinces, and to the damage done through excessive grazing They quoted numerous cases, such as Banda, where, in the famine of 1878 79, grazing areas had been instrumental in saving thousands of cattle, and other instances, such as Jhansi and Rohtal, in which thousands had perished for lack of these areas They asked, therefore, the attention of Provincial Agricultural Departments to this question, and the co operation of the Forest Department It was suggested that enquiry should be made by district officers, with a view of ascertaining how far cattle needed protection, and what lands, either Government property or else purchasable at reasonable rates, were available for the formation of what were thenceforth to be termed "Fuel and Fodder Reserves" Government of India's Resolution of March 1883

It was recommended that the purchase of land should be effected, provided the price came within a limit of Rs 20,000 for 10 square miles The actual management of the "Reserves" was intended to be in the hands of the Forest Department

Enquiries were next made, at Government suggestion, as to whether suitable spots for "Fuel and Fodder Reserves" existed along canal banks and lines of railway.

As the result of the enquiries made, it was ascertained that in the Doab (North-West Provinces) saline land (usar) could be Action taken in North-West Provinces and Punjab

obtained in abundance, and also a certain amount of *ravine* land, both of which would pay for growing trees and grass upon Ravine lands at Etawah and at Jhansi were subsequently taken up, and canal plantations have been established at Cawnpore, Agra, Rurki, Delhi, and other parts of the North-West Provinces and the Punjab Other plantations, such as those of Changa Manga, and Shahdara, near Lahore, had been previously created by the Forest Department

Mention was made just now also of the "reserves" established at Ajmere-Merwara at the instigation of Sir D Brandis

Action in Madras

But it is in Madras that more has been done than anywhere else to assist agriculture by means of the forests One great reason for this is, that in this Presidency the waste land is the property of Government, and they can therefore dispose of it as they like This is also the case in Bombay, and wherever no permanent settlement of the land exists. The exceptional circumstance that Ajmere-Merwara was under the direct control of the Government of India enabled land similarly to be taken up there for the purpose of forming "reserves." Again, in Madras, cultivated land is more or less mixed up with undulating wood producing country, and thus field and forest come in close proximity, presenting a great contrast to the vast level plain which includes the Punjab, North-West Provinces, and Bengal.

The large timber-producing forests

164 I propose now to deal in succession with the different ways in which at present the supply of wood is maintained, and then to consider in what directions extension for agricultural ends is most needed

First of all come the large *timber producing forests* Everyone must recognise the necessity of having these, they supply Europe with teak, for example, and are requisite for all building purposes, and for providing railway sleepers, furniture, etc As we have seen, they are for the most part still removed from the general area of cultivation, and it is mostly on the hills and mountain ranges that they are found They are clearly demarcated and defined as being forests for the primary purpose of supplying *large timber*, and should, I think, be rightly treated as such

In them the main end should be kept in view, and every means be used to grow as fine and as large timber as may be required From these forests grazing must be excluded entirely, if the forest be worked on the *jardinage* system (that according to which trees of all ages, from seedlings to mature trees, are mixed up together, singly or in groups, everywhere over the whole area, the fellings being similarly located at short intervals wherever a suitable tree may happen to be) The object being to encourage natural reproduction and re-stocking, grazing would do great damage, inasmuch as the seedlings would speedily be nibbled off or trampled down. If the forest be worked in blocks, trees of like age being classed

into separate groups, it would perhaps be possible, without direct damage to the forest, to admit grazing into particular blocks at certain times In any case, in time of drought these forests would be the means of keeping alive many of the cattle of the country But, beyond this exceptional event, in forests of this class I should like the forest officer to have full liberty and every facility for growing large timber independently of any minor considerations, also, I think that he should be allowed to strictly enforce rules for preventing forest fires and for excluding grazing, etc, as well as all others that are necessary to the attainment of his main purpose.

It is, in short, impossible to have timber forests and agriculture on the same area, the most that these forests can do for agriculture is, to provide, for the immediate vicinity, a certain amount of small wood and firewood obtained from the timber that is felled, and to serve as a refuge for cattle in time of drought and famine.

Impossibility of having Timber Forests and Agriculture on the same area

[illegible]

cultivation, and they could not now be brought to benefit directly the actual cultivators of populated villages at a distance. Around them is only a scattered agriculture and a meagre population Here, I should say, are forests which by their position are best adapted for *timber-growing* purposes, and for such purposes they should be kept They are too far off to supply the cultivator with firewood at a rate which he could afford to pay, and which would at the same time be remunerative to the Forest Department, whilst, to the cultivator, even were there any considerable agricultural population, the cost of carting would be prohibitive It may, however, pay quite well to remove large logs, such as contractors or railway companies would buy I am obliged, therefore, to look on these forests as likely to do but little to increase the supply of manure available for the land through the substitution of wood for cow-dung as fuel

Whilst advocating the closer attention of the Forest Department to agricultural ends, and commending the step taken in 1884, which brought the Department under the Imperial Department of Agriculture, I have no wish to urge interference with the necessary and legitimate purposes which the large timber-growing forests serve for the good of the country. Large timber is, and always will be, required, and to make the supply a means of obtaining a large revenue is a very proper end, where, as I have shown, other interests do not suffer thereby. I am, accordingly, in full sympathy with the Forest Department in their contention that, where the object is to grow timber, it is necessary to close these forests altogether to grazing or at least only to open certain blocks at a time, and to enforce stringently the rules which exist in regard to the prevention of forest fires I have myself seen, over and over again, during my tour through the Coorg forests, instances of the damage done by forest fires, how that seedlings are killed and the entire natural reproduction, so

Necessity of maintaining Forest rules as to grazing and fires.

essential in a timber forest, is completely stopped. I can quite understand, too, the damage that will be done in a forest where reproduction is going on, either on account of cattle trampling down the seedlings, or by goats pulling down the branches and young trees bodily, or by goats and sheep nibbling off the young shoots. Goats, in particular, must have no place in a forest of this kind

Much has been said by certain writers in favour of the annua setting on fire of the forest grass, in order to get a fresh growth of herbage The occasional clearing of the coarse dried grass by fire may result in the growth of a temporary crop of fresh grass to feed cattle for a month or so, but it simply means ruination to the forest, and the infliction of damage from which the forest will not for many a year recover I have, therefore, no sympathy whatever with those who have maintained that it is a good thing to have an annual burning of the forest grass, or

grazing

f forests

timber-

Classification of Forests

165 The Forest Department recognises three classes of forests (1) "Reserved Forests," or those which, being the property of Government, or over which they have proprietary rights, have been set aside and constituted "Reserved Forests," (2) "Protected Forests," or those which, though the property of Government, or over which Government have proprietary rights, have not been included in a "reserved forest," in these Government may declare any class of tree reserved, or close any part for a term not exceeding 20 years, (3) all other forest lands are termed "Unclassed Forests"

Protected Forests

166 Of "Protected Forests" I need say little more than that I think it would have been very much better to have made them all "Reserved Forests" The retaining of certain rights by Government, and allowing the people to do otherwise as they like is not conducive to the forest serving the best purposes

In many cases, notably the Punjab, the creation of "protected" forests has arisen, I believe, mainly from the fact that the Local Government have not had the courage to extend full protection to land which ought really to have been "reserved" forest. A partial protection only has been extended to them, the Local Government fearing to cause friction with the people In view of the important issues of forest preservation, the reckless use of the forests by the people when uncontrolled, and the general unsatisfactoriness of the working of "protected" forests, it would, I think, have been much better to have taken the bold step at the outset In the case of any land that is reserved, exclusion from it may be necessary for a time at first, but before long the benefit of doing this will be apparent, and even in the first year a quantity of grass will probably be available for cutting as fodder

Reserved Forests near cultivation.

167. Among "Reserved Forests" are included the timber-growing forests which I have referred to in paragraph 164. I now intend to deal with those "reserved forests" which are near the cultivated areas, and which can be made to serve agricultural ends The action taken by the respective Governments of India, Bombay, and Madras in extending the influence of the forests from the hills to the cultivated plains was, undoubtedly, a good one But, from one cause and another, it has come about that, with ... rdly ... the ... t as ... ng a benefit for them

The advantages not fully realised by the people

It is necessary to look briefly at the causes which have brought this about Undoubtedly in the past there has been a tendency on the part of the Forest Department to grow large timber only, and to reap a large revenue by doing this We have seen, in paragraph 157, how this naturally came about, and that it was the result of the duties with which the Department was charged at the outset But the traditions have not altogether passed away even now, and there is still need of reminding the Department, as Sir D. Brandis did in 1883, that the growing of big timber is not the only, and often, indeed, may not be the main, object of a forester's existence.

The reasons for this.

The traditions of the Forest Department

Sir D Brandis wrote in 1883 —

"It must now be distinctly recognised that not only does the provision "of timber and firewood come within the legitimate scope of forest admin-' istration in India but one of its most important duties will, in future, be ' to increase the supply of cattle fodder particularly during seasons of drought "in the drier districts'

There have been, undoubtedly, considerable difficulties in the way of the Forest Department, and where, as in the case of Ajmere Merwara, there has been no hindrance to procuring land, the Department has shown its readiness to minister to the more agricultural needs as well as to the growing of timber.

Difficulties in procuring land

Nevertheless there is, I think, a great deal more that can be done, and what is chiefly needed is, to extend the action taken by the Madras Government.

I should, in justice, say here that among the officers of the Forest Department there are many who recognise the importance of the objects to which Sir D. Brandis refers, and who carry them out as far as they can. Some such men I met during my tours.

168. What prevents extended action is not any check from the Government of India, nor yet from the Forest Department, but it is a financial check, and one which accordingly prevents Local Governments from taking action The Forest Department is practically called upon to show a large revenue, and is naturally proud of the profit it makes At the same time it is a notoriously undermanned Department, but is unabl

Difficulties in the way of extended action in an agricultural direction

The financial check

materially (as would be necessary were the more agricultural purposes closely followed), unless by showing a still larger surplus to meet the expense of additional officers So it has come about that, in the majority of cases, the officers have turned their efforts mainly to producing large timber wherever they could, even though the circumstances of the "reserved forests" would, in the wider sense of the good of the country as a whole, have often adapted them better to other purposes than timber growing

'Reserved Forests often better adapted to other purposes than timber-growing

169 It is by no means the case that timber-growing will always be the purpose to which the forest is best suited naturally, or the most desirable one when all considerations are taken into account Areas have been taken up in the past, and the attempt has been made to grow on them timber for sale, whereas these areas were never fitted for such a purpose, but only for growing scrub-jungle and for providing grazing. There are many such instances in the Madras Presidency. If the Forest Department is told to conserve timber it will do it, and wherever it sees a chance What must come to be understood is that forests may be so situated or naturally so adapted that timber growing may not always be the main end to be sought, but that what the forester is accustomed to regard as "accessories," such as small timber, firewood, grass, etc, should, in many cases, be the main consideration, and that for which the forest should be worked. In some of the Bombay forests, for example, the supply of twigs and leaves for the *rab* system of making seed-beds (see Chapter VII, paragraph 131) may be the most useful aid to agriculture, and the growing of trees that may be pollarded would do much more good than supplying timber At Mahim (Bombay) and Hospet (Madras) I saw cultivators lopping the trees around their own fields, the twigs and leaves being utilised either for *ráb* or else directly as manure for rice fields. Nor were the trees ruthlessly destroyed, for they were only lopped once in four years Similarly, some trees are most usefully grown for pollarding, the shoots being used as props for plantains or *betel* vine At Mahim I counted over 50 new shoots on a pollarded *bhendi* (*Hibiscus*) tree, and I was told that the number went sometimes up to 100 The shoots take three years to grow to a sufficient size, and the trees live for 40 years I could not help thinking it was much better for the trees to thus yield a triennial supply of shoots for 40 years, than that they should be left alone all the time in order to afford at the close of it one single log of timber

Rab

Pollarding and lopping of trees

Where such is the case, and seeing that in wet regions the *ráb* system has been proved to be the best for rice cultivation, it would frequently be very legitimate for the Forest Department to work for the supply of *ráb* instead of for timber The Forest Department have, in some instances, tried to undertake the provision of *ráb* but the difficulty has been that they feel compelled to cut it according to rule, and then to stack and keep it, whereas the cultivators must have it fresh, and just when they want it, as well as at a not expensive rate

170. In demarcating a "reserved forest" it is the practice to ascertain, register, and provide for the continuance of rights which are found to be already existing over such areas. But more than this is required. It is not enough to satisfy existing rights, or to provide for the wants of the people *immediately* around the reserved area, and then to say, "Having done this, "we will now grow our timber." What I maintain is, that, having marked off the most suitable and more distant areas for timber-growing, the "reserved forests" which are nearer cultivation should be worked more in the interests of the people than has been the case in the past, and that the *first* consideration, and not the *last*, should be how the wants of the agricultural community generally (who are not fortunate enough to have acquired any rights) can be best met, and how the benefits which the forest reservation [illegible] nded to as wide an area as possible [illegible] stance beyond which firewood, etc, [illegible], my contention is, that the object to be kept in view should be to see *how large a number* of the cultivating villages *can* be provided for, not *how few must* have their actual rights supplied. When this is done, I have not a word to say against the remainder of the forest being utilised for timber growing, for sale of fuel to towns, for letting out to graziers, etc, whichever be possible and most remunerative, but these must come *after*, and not *before*, the agricultural needs of the country.

The provision for existing rights.

171. It is right that I should here make an exception in favour of what has been done in Ajmere-Merwara. The reserves here, which I had the pleasure of visiting under Mr. H. C. Hill's guidance, quite meet the ends which they should fulfil. No attempt is made to grow large timber (the soil, indeed, is quite unsuited to it), but large quantities of small wood and of firewood are produced, and a considerable amount of grass is cut for fodder, whilst, even during my visit, the reserves had, in a time of drought, been the means of saving a number of cattle belonging to the surrounding villages.

Exception in favour of Ajmere Merwara.

I am told that similar reserves may be found in different districts of the Punjab.

If the example of Ajmere-Merwara were to be followed extensively, much good would certainly result, but, as it is, there is room for improvement, and my remarks made above hold good, I believe, in general.

172. As to firewood, it is quite true, as forest officers have pointed out to me, that the price of firewood must be regulated by the demand, and that firewood cannot be sold at one rate to a town and at another to the cultivator, or else the latter will at once re-sell his purchase at a profit. But, what I think might well be adopted is the system by which the inhabitants of certain defined areas around a "reserved forest" might be allowed, on payment of a certain yearly sum, to take out an annual license to remove what wood they require for building, implements, and firewood, as also fodder, etc, provided these

System of annual licenses in reserved forests.

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Reserved Forests often better adapted to other purposes than timber-growing

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Rāb

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172 As to firewood, it is quite true, as forest officers have pointed out to me, that the price of firewood must be regulated by the demand, and that firewood cannot be sold at one rate to a town and at another to the cultivator, or else the latter will at once re-sell his purchase at a profit But, what I think might well be adopted is the system by which the inhabitants of certain defined areas around a "reserved forest" might be allowed, on payment of a certain yearly sum, to take out an annual licence to remove what wood they require for building, implements, and firewood, as also fodder, etc, provided these be for their domestic System of annual licenses in "reserved forests"

use only, and not for sale; also to graze (when grazing can be provided) all cattle of which they are the *bonâ fide* owners. This would get rid of any difficulty as regards the price of firewood, and, inasmuch as the licenses would specify the particular blocks where the permission could be exercised, and would be liable to be cancelled if the restrictions were exceeded, the control would lie with the forest officer, who would determine the areas to be thus set off.

The only difficulty would be in the case of those who hold rights of grazing, of removing firewood, etc., and who would hardly be willing to pay an annual sum when before they had been free. This would, however, not apply everywhere, and where it did, the rights would have to be defined, just as is done at present in the case of "reserved forests."

The Forest Department undermanned.

173. I have spoken of the need of a larger staff of better-trained men in the Forest Department to carry out the working of forests in an agricultural direction. As the forests come more in contact with agriculture, so will there be need of greater supervision and more official protection against fire and against unauthorised grazing, etc. To take an example, in the Coorg forests there is only one European professional officer over an area consisting of 248 square miles of "reserved" forests, and 601 square miles of "protected" forests.

The Forest Department sometimes tries or is expected, to perform impossibilities.

174. But the Forest Department is sometimes called upon, or else attempts, to perform impossibilities. When the need for serving agricultural ends has been impressed upon them, the officers have frequently been expected to produce out of the same forest large, medium sized, and small timber, firewood, leaves, *ráb* material, and grazing all at once. In Bombay the Forest Department has decided that these varied wants can best be met by a 40 years' rotation. This means that *ráb*, for example, could in any one year be only taken off one fortieth of the area, a very insufficient amount in many cases. It is quite clear that cutting for *ráb* must be done near cultivation, and that there must be regular working plans drawn up for it, the people being allowed to cut the material themselves over allotted areas, worked, say, on a three or four years' rotation, and payment to be by levy on the rice area cultivated, or on a village as a whole.

Again, the agriculturists being under the Revenue officials, there are not wanting instances where, owing to the absence of a proper understanding between these officials and those of the Forest Department, friction has been caused upon the closing of the forests, or by the issue of orders to stop the lopping of trees for *ráb*.

Summary of difficulties of Forest Department and its future policy.

175. Thus, partly from the nature of its action, of necessity a restricting one, but mainly from the obligations put upon it by the Executive Government, also from the impossibilities it has been asked to perform, and, lastly, from being greatly undermanned, the Forest Department has not been as popular in the past as it might have been. But I am sure that when it is fully recognised that

there are other ends which the Forest Department should serve besides that of growing timber and making a large revenue out of the forests, the Department will readily carry these out to its best ability.

Such an end is that which I have indicated, the provision, for the agricultural community *primarily*, of facilities for obtaining what they require, *viz*, small timber, wood for implements, firewood, leaves, grass, or, where possible, grazing No action would, I am sure, do more to render the Forest Department popular and its work one of wide-spreading benefit, could it be instructed to carry out such objects as the above, and to bring these facilities to the cultivators' doors Such a policy would be one of *giving*, and not what the people have considered the past policy, one of *taking away*. The cultivators would then feel that the forests were a real benefit to them, and possibly much unculturable land would become clothed with trees and grass

I cannot better conclude the consideration of this portion of my Report than by giving the following extract from a Resolution of the Madras Government, issued in October 1890, upon this subject:—

Resolution of the Madras Government October 1890

Paragraph 24 —" It is, however, most necessary to correct the "idea, which prevails somewhat widely, that as soon as a forest is "reserved, cattle and men are to be excluded, and it is to be worked "for the profit of Government rather than for the benefit of the "people It cannot be too strongly affirmed that the chief object "of the reserved forests throughout the greater part of the country "is the provision of pasture, small timber, fuel, and leaves for "manure or litter. These are to be worked in order to meet the "wants of the villagers in these respects, and are not to be con-"verted into close preserves for the growth of large timber "

This important Resolution exactly expresses the opinions I had already formed, and it is in the direction indicated that I think future policy should proceed

The policy of Government

176 I am aware that changes cannot be effected without expenditure of money, and perhaps a diminished revenue may be the result, at least for a time. But I have attempted to show that the obtaining of a large revenue from the sale of timber may not be coincident with the best interests of the country at large, and that a possible diminution of it may be attended by increased revenue to the State from cultivated land. It has also to be remembered that a very large portion of the revenue of the Forest Department is derived from rich grazing grounds which have been transferred to it from the Land Revenue Department The Forest Department, in being a revenue-earning one, starts with the following advantage in favour of its old policy as against the one I recommend, that, if timber be sold, the return is an *actual* one, whereas if the plan I advocate be followed, the increase will be a *potential* one, it cannot be directly translated into figures. Nevertheless, I trust I have said enough to show that action in the direction of providing for agricultural wants, and primarily as regards the supply of fuel, is inseparably bound up

with the prosperity of the agricultural classes, and with the maintenance of the Land Revenue of the State

Plantations along canal banks, railway lines, etc.

177 Next to the forests come the plantations which have been established along canal banks, lines of railway, and other selected spots, primarily for the supply of fuel to towns and railways, and not with special agricultural intent As mentioned in paragraph 163, plantations have been made along the banks of canals in the North-West Provinces and the Punjab, and such towns as Cawnpore, Agra, Rurki, and Delhi are thereby supplied with fuel It was reported in 1889 that in the North-West Provinces there were 36,037 acres of plantations along the banks of the Upper Ganges, Lower Ganges, Agra, and Eastern Jumna Canals These are, however, under the control of the Irrigation Department, and not of the Forest Department, and no effort is made to create a local market for the wood, hence it all goes to the large towns, and the plantations are of little local agricultural use In addition, the system of letting out grazing is by no means satisfactory, in many parts the cultivators arrange among themselves, so that there is no competition for the privilege of grazing and one man will thus purchase the right of grazing over an extensive area for a merely nominal sum, putting on as many cattle (including his neighbours') as he can, and in turn receiving payment from those whose cattle he admits In other cases grazing is not allowed, but only the cutting of grass If the working of these plantations were put under a forest officer they would probably be better seen to Along the Cawnpore Canal the plantations are 40 feet deep, *babul*, *neem*, *pepul*, and other varieties of *ficus*, *dhák* *sissu*, and *jarman* are the principal trees grown The native proprietors (*zemindars*) in the neighbourhood sometimes have plantations of their own, mostly of *dhák* and *babul* wood, every three years they cut these over and send the wood into Cawnpore

Changa Manga

Changa Manga is a large plantation of 10 000 acres situated along the North-Western Railway, and watered by the Bari Doab Canal It was started in 1866, and its object was to provide fuel for the railway *Shisham* (*Dalbergia sissu*) is the tree grown, and it is cut on a 15 years' rotation I found on enquiry, that the railway company takes the whole of the wood although only supposed to have that which is above 2 inches in diameter The smaller wood, 1 to 2 inches in diameter, is re sold by the railway company A large quantity of grass, mostly of a coarse nature, grows in the plantation and to this I shall refer in the next chapter But I would mention that, so far as I could see, the Changa Manga plantation does not serve any agricultural end whatever, except within a very limited circle It simply supplies wood for the railway, instead of the latter burning coal. Nearly the same remark may be applied to the Shahdara plantation, near Lahore, established in 1865, and covering 1,254 acres The river is close at hand, and the soil is moist in consequence, *sissu*, again, is the wood grown The original intention was to supply fuel for the railway, but now the whole of the wood goes to a contractor at Lahore, for use in the

town as fuel. Occasionally a little grazing is allowed, but the forest officers are evidently adverse to it.

None of these plantations, accordingly, whether along canal banks or elsewhere, serve agricultural ends as usefully as they might be made to do, and improvement in the system of their working is possible ... which, like Changa ... benefit the land, ... even to towns, a certain amount of cow-dung is released which might otherwise be burnt as fuel. These plantations have little agricultural value

178. More agricultural in purport than the foregoing is the system of Arboriculture, the spread of which has been pushed on with commendable energy, mainly by the Directors of Provincial Departments of Agriculture. Apart from a possible influence on climate, the provision of shade and shelter, and ultimately of timber and fuel, cannot but be beneficial. If trees such as the *prosopis*, the *mahva*, and the *jack-fruit* tree, were grown, they would in time of famine be very useful in supplying the people as well as the cattle with food. The fruit of the *babul*, for example, is a very good food for cattle. Arboriculture

It is very desirable to encourage the planting of trees by private individuals, and to hold out inducements for the doing of this The feeling of possession, as instanced in the case of a man digging his own well, is one that acts as a strong incentive to agricultural improvement, and it should be fostered in every way. In Prince Edward's Island "arbor societies" are formed with objects similar to the above, and in several States of America special inducements are held out for the taking up of land for the purpose of growing trees * Wood growing in America

... was introduced ... to be allowed ... plantations on ... erative, for if ... area he got ... de use of. I consider that a great deal ... the North-West Provinces ... *In 1888-89, Rs 68,989* ... on Arboriculture, and the receipts amounted to *Rs* 47,084 In the Central Provinces, during the same year, 29,000 trees were planted. But in Bengal and in Bombay little has been done. In a part of the country where, as in the North West Provinces, the forests are confined to the hills, and wood and shelter are notoriously deficient, it is of the greatest importance to show the benefit which the planting of trees along road-sides may confer *Casuarina* is a tree well suited to sandy lands, and the growing of it in parts of Madras has "Tope" rule

been very successful In the Native State of Kapurthala I noticed that plantations of *sisu* and other trees had [illegible] made on bare places around the town of [illegible] ossible. The nat[illegible] the example set, [illegible] (*shamilat*) has beer [illegible] *babul*, wells are surrounded by trees, and mango trees are planted along watercourses, some villagers have even planted small gardens, and the State, as an encouragement, remits the revenue of all such lands In driving along the road from Jullundur to Hoshiarpur I frequently saw *sissu* trees which had been planted by *zemindars* in blank patches of the fields just off the roadside.

Undesirable to plant trees close to cultivated fields

It is well, however, that I should here interpose a caution as to the undesirability of planting trees, more especially *babul*, close to the edges of cultivated fields, at least where cold-season (*rabi* crops are grown. The roots of the trees run out in search of moisture and nourishment, and thus deprive the crop of each, especially the former. I have seen numerous instances of a *rabi* crop being damaged in this way, with rainy-season (*kharif*) crops and where there is abundant rainfall, it does not, however, matter.

The need of creating more "reserves"

179 But, after all, and even were the existing "reserved forests" to be devoted, where possible, more to agricultural ends, there would not be enough reserved areas to meet the demand. The "reserved forests" can only serve a certain circumscribed area, and there must yet remain, especially in the North West Provinces, large tracts where trees, much less forests, are almost unknown. It is in such districts, untouched by forests, that the endeavour must be made to *create* "*reserves.*" It is hardly necessary to say much in proof of the above, the fact is almost universally *admitted*. The following instances, gathered in the course of my tour, may, however, be usefully given, as showing the scarcity of firewood, and that the price of it is more than the cultivators can afford to pay in order to replace cow-dung by wood for fuel —

Instances of the scarcity of fire wood

North West Provinces

At Cawnpore the price of firewood is 4 annas *per maund* (80 lbs) or 1 rupee for a little more than 300 lbs., whereas 100 pieces of sun dried cow-dung cakes (*bratties*) only cost 2 annas or 1 rupee for a whole cartload, weighing some 700 lbs., about three cartloads going to the ton

At Rurki, which is supplied from the canal plantations, firewood costs *Rs* 22 for 100 maunds, making the price $5\frac{1}{2}$ annas a maund, or much the same as at Cawnpore

Punjab.

Ferozepore is very badly off for firewood, [illegible] rade tracts. The land here [illegible] ue of this [illegible] country, wood for implements

[illegible]ombay

181

In Bombay itself, firewood costs *Rs* 2 for 10 maunds (80 lbs each).

At Poona it is very much dearer, and especially hard to procure, inasmuch as it has to be fetched 30 or 40 miles The cost in Poona is 8 annas a maund, or *Rs* 5 for a cartload, whereas a cartload of dried cow-dung cakes (*bratties*) costs *Rs* 3, and a cartload of loose cow dung 1 rupee only

Ahmedabad also is badly off in this respect, the maund here is only 40 lbs, and 1 rupee will purchase only 4 maunds of firewood, or 160 lbs

At Mahim firewood has to be fetched from the forest, this implies a three days' journey there and back, the cost for a small cartload is 8 annas.

The cost at Belgaum is *Rs* 2 to *Rs* 3 a cartload, but it has to be fetched from a distance of eight miles off

Coorg

A cartload of 1,000 lbs. of firewood costs *Rs* 2½ at Shiyali, and at Madura a bandy-load (three to the ton) sells for *Rs* 4 to *Rs*. 5, but it has to be brought some 20 miles Madura

Mr Benson, writing about Bellary, says —

"The supply of cattle manure is small, except in a few places, owing to the "scarcity of wood for fuel One of the greatest wants of the district agricul-"turally is a better fuel supply, and this is an object which is worthy of the "most careful attention."

Mr Nicholson says of Kardr:—

...nting of hedges and ... building timber is ... illachi firewood costs ... s being 10 and 12

Mr. Basu writes thus of Chota Nagpur —

... to buy fuel No improvement under ... lace until fuel is rendered cheap and ... es belonging either to Government or ... d is scarce and jungles inaccessible" Bengal

I could multiply these by a great many other instances which I have met with myself, or which I have collected. In Chapter VII, paragraph 123, I have already shown that wherever wood is sufficiently plentiful it and not dung is the general fuel, and that manure being thus set free for the land, the cultivation has benefited immensely; such instances are Nadiad, Hospet, Avenashi (Coimbatore), Hoshiarpur, Multan, and many others.

As affording a contrast to the remark made above by Mr. Benson on the scarcity of wood in Bellary, another quotation from that gentleman, when speaking of Cuddapah, will illustrate my point well:—

"The abundance of fuel in the neighbourhood prevents the use of *bratties* "extensively for fuel, so that the soil receives a good deal of what is removed "from it by the crops raised"

180. Having instanced sufficiently the need of more firewood for agricultural purposes, I must now express my concurrence with the views that have been expressed both by Governments and by individuals, that the way in which the supply of wood to agriculture can be best increased is by the *creation* of new enclosures of land for the purpose of growing wood, scrub, jungle, and grass Such enclosures are now denominated "Fuel and Fodder Reserves" The need is best met by the creation of Fuel and Fodder Reserves.

I shall indicate briefly what has been done in this direction, and then try to point out in what way extension or modification of the system is called for.

Opinions in favour

The establishment of "Fuel and Fodder Reserves" was advocated successively by Sir D Brandis in 1873, by the Famine Commission in 1879, and by the Government of India in 1888, acting upon the recommendations of the Famine Commission (*see* paragraph 163).

S Edward Buck

Sir Edward Buck, when an officer in the North West Provinces, warmly advocated the establishment of these "reserves," and to him is mainly due the initiation of experiments on their formation over ravine lands and salty land (*usar*) plains in the North West Provinces (*see* paragraph 75)

Mr J B Fuller

Mr J B Fuller, writing on the subject in 1887 says —

'The desirability in the interests of the people of establishing fuel and 'fodder reserves is admitted on all hands

The Madras Resolution Oct 1890

More recently (October 1890) the Madras Government issued the important Resolution on the policy of their Forest Department, to which reference was made in paragraph 175, and from which I will now further quote —

Para 6 —' The question of the provision of fuel is hardly 'less important than that of pasture In many parts of 'the Presidency the supply of firewood is so scanty that 'the people suffer considerable inconvenience and discomfort "But this is not the worst, wood being dear, the dung of 'cattle is used in its place, and the soil is thus deprived of the 'manure of which it stands in such urgent need Any 'measures, therefore which tend to improve the supply and 'lower the price of firewood would be of immense advantage 'to the cause of agriculture in this country"

Para 7.—"For the reasons set forth in the preceding "paragraph, His Excellency in Council is of opinion that the 'establishment of fuel and fodder reserves is most desirable "in the interests of the cultivating classes."

Para 24 —"Further, the Government advocates, if the area 'already taken up is not enough to furnish the estimated "requirements in firewood, leaves and small timber and to 'afford grazing for all cattle necessary for agricultural or "domestic purposes, more land should, if possible be brought "under management, and the natural jungle growth should be "supplemented by plantations created for the purpose of fuel 'supply"

In the above extracts is contained the acknowledgment that the supply of firewood is still very deficient, and that existing resources are not enough, but that new reserves will have to be *created*.

Fuel and Fodder Reserves already created.

181 We will now see what steps have been taken in this direction since Sir D Brandis and the Madras Government moved in the matter, and since the Government of India proceeded to act upon the recommendations of the Famine Commission.

Patri forest Burki

The earliest "Fuel and Fodder Reserve, in the strict sense that I can find mentioned is the Patri forest near Burki North West Provinces

This plantation was begun in 1871, five blocks, comprising in all 80 acres, being demarcated, and trees, mostly *sissu*, being planted and watered by a cut taken off from the Ganges Canal Sir D. Brandis reported in 1881 that it was doing well He suggested that it would be necessary to keep out cattle at first, but by and by to permit grazing in protected blocks, admitting only certain villages and making them responsible for the protection This practically was of the nature of a "village forest," and was agricultural in intent

Ajmere Merwara.

The forests of Ajmere-Merwara, although of large extent and under the Forest Administration, are really "Fuel and Fodder Reserves" on a large scale I have shown how the Government of India were able to deal with them straight away, having a direct control over them As I have said, they more nearly approach to my idea of what "agricultural forests" should be than anything else which I have seen or read of under the Forest [illegible] are *not enough* Ajmere- [illegible] done there, but there [illegible] swer of the Forest Depart [illegible] t, and it is seldom that [illegible] is under direct Imperial control [illegible] tell later, [illegible] well as [illegible] banks, I [illegible] Department had been more alive to agricultural needs, and less anxious to show large financial returns more might have been done in forming other "Fuel and Fodder Reserves" like Ajmere-Merwara

[illegible] reserves in 1873, by taking up and [illegible] g around one side of the valley, where [illegible] the other side were left as they were, [illegible] tions, but were left free for whatever grazing or cutting of wood they could supply

The villages included in the reserved part were handed over to the Forest Department, who allowed the villagers to cut and remove grass from November to February, and to have grazing from March to June Further, the villages were to receive two thirds of any surplus revenue and all the grass No planting was done, but grazing was prevented, except in specified parts, and wood was only cut as allowed No regular enclosure was adopted, *euphorbia hedges* and *stone walls only being put up here* and there In a few years there was a complete transformation, the bare hills soon clothing themselves with small trees and scrub, while grass sprung up in abundance

In 1881 Sir D Brandis wrote in reference to them —"In all, except the "most arid tracts . . . mere protection, aided by sowing and planting "in suitable places, will gradually clothe grounds with trees and shrubs

I visited the [illegible] pointed out to me [illegible] shrub, and grass, [illegible] and unclothed. T [illegible] could see it withou [illegible] as helped [illegible] has thus [illegible]

The principal trees are *zizyphus*, *anogeissus*, and *babul*, and a considerable sale of dried and dead *euphorbia* bushes is also effected

[illegible] to the hills around Ajmere [illegible] slope near the town, and [illegible] likewise Here the soil is [illegible] s a wonder that anything [illegible] le grazing can be afforded a good quantity of grass is cut, and *zizyphus* and *babul* trees grow very fairly.

From Ajmere I went to see the "Chang reserve," another one forming part of the Ajmere-Merwara forests, and about six miles from Biawar. This was begun in 1875, and comprises 3,000 acres. Here, again, the contrast between the protected hills and the unprotected ones was most marked. A great deal of firewood is cut by contract, and carted to Biawar, 2,400 camel loads (150 lbs each) and 6,572 head-loads of small fuel, coming from the "reserve" in the course of the year 1888-89. No attempt is made to grow large timber, but in the better parts *neem* seed is dibbled, and this tree does very well. Reproduction goes on very satisfactorily indeed, and protection from fire and trespass is well maintained. The grass is, as a rule, cut and removed, but the forests, in time of drought, are thrown open to grazing.

Similar "reserves" which I had no time to visit, lie nearer Merwara. The whole area comprised in the Ajmere-Merwara forests is 89,264 acres. In 1889-90 six areas of village lands 4,393 acres in all, were voluntarily made over by the people to the Forest Department for management by them, and were constituted 'village reserves.' To show the value of the Ajmere-Merwara forests, it may be said that, in 1889-90, owing to failure of rain and scarcity of fodder, nearly all the reserved area was thrown open to grazing during part of the year, and no less than 14,684 head of cattle were allowed in. The fire lines (dividing the "reserves" into isolated blocks for preventing the spread of accidental fires) are burned by the people in return for the grass removed.

I have mentioned the case of the Ajmere-Merwara forests rather at length, as it is the best example of what should be tried elsewhere. The financial result at the present time shows that expenses have just been met, but, to my mind, the good that has been done, but which cannot be actually translated into figures, represents a very considerable surplus. The mere supply, to an agricultural district such as this, of wood to replace dung as fuel must be highly beneficial, and would be even more so did not Ajmere labour under the difficulty of a very uncertain and often failing rainfall.

My other instances of Government experiments must be drawn from those on ravine and salty (*usar*) land, for I have already spoken of canal plantations and others, such as Shahdara and Changa Manga, and have shown that their ends are not, in the main, agricultural ones. Even ravine and *usar* lands I have previously fully dealt with in Chapter V, paragraphs 70—76, and need say little more about them now.

Etawah, Jhansi, Cawnpore, and Awa are the chief places where tree-planting has been tried to any considerable extent, for on the *usar* land at Aligarh it has only been done on quite a small scale, and the efforts have been confined mainly to grass and crop-growing. I may here point out the financial success attending the enclosure of ravine land at Etawah.

Etawah.

About 1,400 acres (7,000 *bighas*) of this land belonged to the native land owners (*zemindars*), and this was of but little use except for cattle to roam over. In 1885 the Agricultural Department of the North-West Provinces persuaded the *zemindars* to let it try the experiment of tree-growing, and got them to advance Rs. 600 for planting *babul* seed over the land. Cattle were kept off, *babul* seeds were scattered broadcast just before the rains came, the trees came up capitally, the grass grew well, and soon, without any artificial irrigation, a useful "fuel and fodder reserve" was formed out of what had been simply waste land. The "reserve" now brings in an annual income of Rs. 1,100, and the *zemindars*, never having parted with the land, take care to keep the proceeds too. Now, had Government done what it might have done

of the "reserve' might have are of the "reserve" is practi- for the time being, he may inated it) and Mr Alexander n to do so, the entire good may be destroyed.

This instance shows, however, how much may, with care, result from an expenditure of *Rs.* 600 only. Similar ravines to those at Etawah extend along both banks of the Ganges and Jumna, and what has been done at Etawah might be followed elsewhere, with great advantage to a Province so destitute of wood as the North-West Provinces are.

Ravine and usar land in North West Provinces

In regard to ravine and salty (*usar*) land, a careful investigation was made in 1883 in the Doab district of the North-West Provinces, by Messrs. W. J. Wilson and Darrah, when it was ascertained that *usar* land could be had in abundance, also that there was a certain amount of ravine land available for "fuel and fodder reserves," " which would come well within as the price of purchase, *viz.*, After making calculations, which were purposely put more unfavourably to the scheme than was necessary, Messrs. Wilson and Darrah concluded their Report by saying :—

"On the whole it appears probable that plantations in the ravines will yield "a very considerable profit, and with *usar*, too, both grass and trees will pay "expenses "

It was pointed out that, while doubtful whether any effect would be produced on the climate, it was certain that erosion of the soil would be prevented in ravines, and that a layer of *humus* would be accumulated on *usar* soil, whilst in times of drought the loppings of the trees would be of great value The Report says —

"The financial loss if it occurs at all, will be trifling and the advantages "of protection of land from erosion, and protection of cattle, in drought, would "well warrant the expenditure "

That the opinion formed was a correct one is exemplified by the result of the Etawah enclosure

Of the success land, the instance given in Chapter

Usar and at Kapurthala

were not fit for cultiva- a salts (*kalar*) *usar* land here capitally supplyin from this and from grazing fees amount to *Rs* 9,000 per annum, with an expenditure of only *Rs* 540 The growing of *dhák* has one great advantage in that cattle, sheep, and goats will not touch the tree, and consequently grazing does not harm it

The growing of *dhák* ought certainly to be much more exten-

and growing grass on it. I should like to see the growing of trees tried more extensively.

Forest Department too much engaged on settling Reserved Forests

182. The question was often asked by me, why the Forest Department has not created more "Fuel and Fodder Reserves." The answer most generally given was, that the Forest Department is still busy over the "settling" of the "Reserved Forests" and that as soon as this is done it will go on to deal with the Village Forests," which these "Fuel and Fodder Reserves" would virtually be

Undoubtedly, progress is hampered by an insufficient staff, but I consider this important question must not be longer delayed

The reservation of land for communal purposes

183. It has been rightly said that one of the curses of the country *is the indiscriminate granting of land without the* reservation of land for communal purposes. I notice with satisfaction, therefore, that Government, in giving grants of land near Multan, along the Sidhnai Canal, have reserved about 10,000 acres for "forest reserve," and that, where the Sidhnai irrigation extends, the lessees may use the trees or brushwood, but may not sell nor exchange it

The practical difficulties in obtaining land for the creation of fuel and fodder reserves

184 Having now established not only the usefulness of "Fuel and Fodder Reserves" where they have been formed, but also the need of more of them, we have to consider the two practical difficulties which have been put forward by those who have even allowed the desirability of the extension of "reserves" These are —

Firstly, the difficulty of finding land suitable for the purpose

Secondly, the difficulty of acquiring it even if suitable

These will have to be treated separately

Considerable amount of land available

185 As to a considerable amount of land being available there can be no doubt to anyone who has gone over the country

It is, however, true that where wood is most wanted there the land is mostly taken up by cultivation, and wood can only be purchased at high rates, but that where wood grows freely there is no cultivation to demand it urgently.

The North-West Provinces and many parts of the Punjab afford instances of the scarcity of wood In the North West the plains are, generally speaking, fully and even densely cultivated [except where salty land (*usar*) exists], whilst the forests are confined to the hilly regions on the northern boundary In Bengal, too it would only in certain parts be possible to extend the existing forests to the more cultivated areas In Madras and Bombay, on the contrary, it would be quite possible

Classes of land available

186 Reserving to the next section the consideration of the way in which lands are to be acquired, I may here name the classes of land which might be available

(*a*) The waste land belonging to Government wherever a *raiyatwari* settlement exists, and including (in the case of Madras,

at least) the sides of roadways, channels, tanks, embankments [illegible]

land. (*e*) The banks of canals and railway lines, [illegible] present under dry cultivation, but which it might pay better to convert into "reserves."

In illustration — Instances

(*a*) In Madras the waste land all belongs to Government. Mr Nicholson reported in 1887 that in the Anantapur district alone there were 1,141,089 acres of Government waste land, and that there were parts where blocks of 1,000 acres could be dug round, enclosed with banks, and then seeds of trees be sown before the rains (a) Government waste land

In his "Manual of Coimbatore" Mr Nicholson mentions places, such as Karúr, Dhárapuram, Kugalur, Palavapálaiyam, Sambiyúr, Udamalpet, and elsewhere, where fuel reserves are needed and might be established Of Karúr he says —"the channel and river banks might be planted with "advantage . . . . the *taluk* is poorly wooded . . . even the most "favourable positions, such as channel banks, deep spots near water etc, "are not utilised . . . . there is one private jungle, but this is left to "nature and not assisted by plantation . . . . it produces *babul* trees and "grass abundantly."

Mr Benson found in Kurnool (Madras) large tracts along the foot of the Nallamalais, which would be suitable for "reserves

Around Salem the hills are not fit for cultivation, but would make good 'reserves"

I noticed myself, when travelling in the Madras Presidency, many channel banks, sides of tanks and roadways, where trees might have been planted

When enquiry was made in the Madras Presidency in 1883 it was found that taking the whole Presidency, 100 acres of land to every village in a *taluk* were available for "fuel and fodder reserves'

[illegible] Provinces in one *tahsil* alone of the Sambalpur district, [illegible] property [illegible] fodder [illegible]

[illegible] on how far it is advisable to take up waste belonging to a [illegible] Provinces, the latter principally, in excess of the people's require [illegible] njab concurs in thinking that [illegible] erves Between Lahore and Amritsar I noticed uncultivated a [illegible] ance, and wherever trees occurred they grew very well (b) Village waste and uncultivated areas

Between Agra and Gwalior I saw a lot of uncultivated land.

In Be[illegible] Mr Finucane found that there were some $37\frac{1}{2}$ square miles in the [illegible] become "fuel ar[illegible] the purchase [illegible] iam other ar[illegible] hem, said —"I do not think any site could [illegible] able "for the formation of fuel and fodder reserves The financial prospects, derivable solely from annual licenses granted to villages, were stated to be very promising

Between Bettiah (Behar) and the Nepaul frontier are strips which might be 'fuel and fodder reserves' This land belongs to *zemindars*, and would have to be obtained by purchase

Also, near Segowlie (Behar) is a good deal of waste land, it having fallen out of cultivation during the famine of 1865.

The report of the Bombay Agricultural Department for 1886 87 speaks of "much land both in riverside villages and others eminently fitted for '*babul* reserves," and the Bombay Government has given remission of three quarters of the assessment to applicants willing to devote land to the extension of *babul* plantations, or to take up new land for it

Such villages are some near Ahmedabad, Nasick, and Poona

In Mysore I observed large stretches of land between the towns of Mysore and Hunsur which were not cultivated but on which large amounts of firewood might be grown In the centre of Mysore, near Arsikeri and Hassan are large tracts that might be enclosed and made into 'fuel and fodder reserves'

(c) Usar land

(*c*) The vast range of salty (*usar*) plains and patches in the North-West Provinces has been mentioned (*see* paragraph 181) Others occur in the Punjab the Deccan the Southern Mahratta country, parts of Madras, and elsewhere Between Delhi and Rewari is salty land on which the tamarisk bush grows well

(d) Ravine land

(*d*) The ravines along both banks of the Ganges and Jumna rivers have been referred to (*see* paragraph 181)

Sir Edward Buck, in a note on the Muttra Settlement, speaks of the feasibility of introducing "*fuel and fodder reserves*" *along the Jumna* Valley tracts and points out that the experiments made at Ajmere and elsewhere 'prove that under proper management large areas will be available "for trees and grazing which are not susceptible to ordinary cultivation'

Ravine land occurs largely at Parhara, near Mirzapur, North-West Provinces

(e) Banks of canals and railway lines

(*e*) The Administration Reports of the Central Provinces speak of there being always areas for brushwood on banks, beds of streams, etc.

The Bombay Agricultural Department Report for 1888 89 regrets the great opportunity which was lost in not securing stretches between Hubli and Gadag *along the Southern Mahratta Railway, and on which babul grows splendidly*

The Bengal Agricultural Department Report for 1889 90 says that it had been ascertained that along the Assam Behar, the Tirhoot extension, and the new Chittagong-Assam lines 'fuel and fodder reserves could be made

(f) Land of dry cultivation

(*f*) It is quite certain that there are many stretches of dry cultivation where crops are taken only occasionally, it may be once in three or four, or even once only in six years but which could be much better utilised by turning them into "fuel and fodder reserves"

About 1400 acres of such land exists at Máhim (Bombay), and is not worth 1 anna an acre for rent

At Avenashi (Coimbatore) is also a lot of dry land, assessed at 1 rupee per acre, which might grow trees well. This is also the case in Cuddapah

In parts of the Deccan, where wood for implements is very scarce, the growing of wood, even if not directly remunerative, would be a great boon to the cultivators.

Mr Fuller thinks that in the Central Provinces it would be good if Government were prepared to remit the revenue of a few fields in certain villages, on condition that the proprietors planted and maintained trees on roads running through it.

Experiment at Bhadgaon of growing a plantation

I might here refer to an experiment now being carried out by *Mr Ozanne* at the Bhadgaon Experimental Farm of the Bombay Government In June 1888 Mr Ozanne sowed eight acres of cultivated land with *babul* seeds put in furrows, one half of the area has had no artificial watering whatever, the other half only one watering, *viz*, in the first year. The interspaces between the rows have been sown with crops of *bajra*, gram, etc At the time of my visit in August 1890, the plantation was growing well, some of the best plants were 4 feet high, and plantation had cost nothing whatever, the *crops* grown between the rows having paid all the expenses

It is very clear, from the instances I have given, that there is a good deal of land on which "*fuel and fodder reserves*" might

be formed, and if only systematic enquiry be made it will result in showing, as Messrs. Wilson and Darrah's experiment in the North-West Provinces did, that there is very much more land available than has been stated.

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fee [illegible]
the [illegible]
ment would be given to native proprietors (*zemindars*) and others to adopt the plan also.

187. Having dealt with the difficulty of finding land, the second one, that of how to acquire it, must be taken. How to acquire land

According to the ownership and the terms under which land is held, so will the procedure to be adopted vary.

Where waste land, as in Madras, is the property of Government there is no difficulty whatever, and, as we have seen, under the term "waste land" is included much land, such as the beds of tanks, etc, which is not available in other Presidencies The matter for regret is, that, with the exception of Madras, and possibly the Central Provinces also, the amount of waste land still left is very small, but where there is any, and so placed as to be of probable benefit to the people if it were turned into a "fuel and fodder reserve," such land should be thus converted. No difficulty with Government waste land

There is one provision I should like to see made, *viz*, that when trees are grown on waste land, such as the bed of tanks and streams, etc, the wood should be devoted *primarily* to the use of the people *around*, and that the trees should not, as is at present the case be periodically cut down *en bloc* and be sold by auction to the highest bidder, often being taken far away from the district. A period then elapses until the fresh trees that spring up are ready again to be cut These plantations (they are mostly of *babul*) should be kept for the wants of the district where they grow, becoming thus really "village plantations," and they should not be cut down in one mass. The natural reproduction should also be meantime looked after Reservation of trees grown on tank beds etc, for local use

188. Next comes the vexed matter of the "village waste," and whether it should be taken up by the Forest Department and worked for the people's benefit. This could not be done without, for a time at least, keeping the cattle off and excluding the people from any use of the land, until the "reserve" was fairly established Where the "waste" actually belongs to the people, it is, I must say, a doubtful policy to interfere with the people's time-honoured rights, and they can hardly be excluded from them without considerable friction being caused, which it is well to avoid. At the same time, as I shall show in the next chapter, the value of the "village waste" [illegible] whether it is not pro[illegible] as feeding areas the [illegible] out of ten, and serve little purpose beyond that of providing standing room and exercise ground for half-starved herds. Nevertheless, it would be very risky to interfere with prescriptive rights The village waste: should it be acquired? This not advisable as a general rule

and, if it is possible, it is better to avoid dealing with the "village waste" What may, however, be hoped for is, that in the more advanced parts the people, after seeing the good which "reserves" have effected in other parts, will enclose it, or a part of it, *on their own account* That there is hope of this being done is exemplified by the instances of Etawah, Ajmere and Kapurthala, already recorded *In these cases land belonging to private individuals and villages was voluntarily handed over to be worked by Government as "fuel and fodder reserves"* (*see* paragraphs 178 and 181)

Possible case where acquisition of village waste is desirable

The one case in which "village waste" might be directly dealt with is where the amount of waste land is manifestly in excess of the requirements of the villages This occurs frequently in the Central Provinces, and also in parts of the Punjab The difficulty of taking up waste belonging to a village is, that only that particular village could share in the privileges, whereas if the land be Government land, or be acquired by purchase, it would be available for as many villages as it could serve Again, *the existence of rights in an enclosed area may hamper future action* and render the dealing with these rights a matter of difficulty

On the other hand it may often be the case that, in order to be of any "these reserves" will have to rts, therefore, the only way to be to appropriate portions of existing village wastes or commons

Village forests

Failure of attempts to create them

Indian Forest Act.

189 The suggestion to form "village forests," which should *include the village grazing grounds and be protected and managed by the people themselves*, was made by Sir D Brandis but the efforts to establish them have successively failed In the Indian Forest Act (1878), a chapter (Chapter III) was for the cons This inoperative, owing, I am informed, to the impossibility of determ se rights, and of rivate rights of for instance, the and thus several people to settle with Anyhow, no "village forests" have been taken up or assigned under this chapter, which is accordingly a dead letter

Land Revenue law of Punjab

In 1886 an attempt was made to amend the Land Revenue law of the Punjab, by inserting a fresh chapter (Chapter VIII) to read as follows —

> "If the majority of the landowners desire or the Local Government considers it expedient that part of the common waste lands of an estate be managed for the production of timber, fuel or fodder the Local Government may proclaim that any part not exceeding one fifth shall be so managed

Expressions of opinion were invited on this suggestion and while a general agreement was come to as to the value of such a measure in the interests of the people, it was felt that there would be difficulty in the procedure and in compulsorily dealing with the village waste The introducer of the Bill, the Honourable

Colonel Davies, on bringing it before the Viceregal Council in July 1886, said —

> "There can be little doubt that a power of this kind is very much wanted "in the interests of both the State and the people, and from my own ex"perience, I think I may confidently state that in many parts of the Punjab "the intervention of Government to bring about the results aimed at by this "chapter will be welcomed by the people"

The Secretary of State, however, on the matter being referred to him in November 1886, considered Chapter VIII as an innovation, and that interference in the internal affairs of villages might possibly be distasteful to the communities concerned, so he expressed the hope that the reply would be very carefully considered.

The subject was thereupon dropped for the time.

Madras Resolution of Oct 1890

The Madras Government, in their Resolution of October 1890, already alluded to, discussed this matter and the various efforts which had been tried Their opinions were expressed as follows —

Para 23 —"The Madras Government now (October 1890) is of "opinion that the idea of village forests must be altogether aban"doned, that it is desirable to have the sources of fuel and fodder "supply under Government control, and to have the reserves in "fairly large blocks."

Government, not communities, must have control of all forests

It is a mistake, I think, to assign any rights to a village community, and to have village forests managed by the community uncontrolled The tendency of our system of government has, to a considerable extent, been to *break up* village communities, and now for the most part they are heterogeneous bodies rather than communities What is wanted is, while retaining control over these forests, to work them for the people's interests

Provision in Central Provinces to control common user

190 Short of actually purchasing land outright, there is a provision in force in *malguzari* tracts, such as the Central Provinces, by which the proprietor (*malguzar*) may be called upon to use excess waste land for the common good

Central Provinces

In the Settlement of the Central Provinces it was stipulated that the rights of ownership to forest land would be subject to restrictions in the interests of the village communities, and of the country as a whole Tenants were to retain their customary rights of "user," and Government had the power of prescribing rules to prevent reckless clearing of land and sale of all the timber

In the Central Provinces Administration Report for 1887-88 it is said —"The increasing value of jungle produce leads *malguzars* "to advance claims of exclusive right to the use of village wastes "and forests and they sometimes cut down and sell all the timber "of their village This is opposed to the principles of *malguzari* "settlement *Raiyats* have a right to the use of the village waste "for grazing and a right to cut wood in the village jungles for fire"wood and agricultural implements"

Extension of such provision desirable

Such a provision is in effect, an Act to "control common user," and the extension of it to other tracts might be usefully employed for the purpose of preserving the fuel supply of villages In Bengal and other *zemindari* tracts an Act might, accordingly

be passed to lay the obligation on the proprietor to grow firewood, and to preserve these supplies for the common good.

The shortest and probably the best way, however, in *zemindari* tracts is for Government to step in and buy the land outright

Land Acquisition Act.

191. It is a question, I believe, whether a simple ruling of section 6 of the Land Acquisition Act could be taken to include the formation of areas for "fuel and fodder reserves" or whether the Act would have to be amended so as to include the formation of these This is a point I can express no opinion upon, except that it is very desirable that Government should be able to purchase land with this object in view The amount of Government waste land, though sufficient perhaps in Madras, is, for the most part, manifestly deficient elsewhere, and the acquisition of fresh land is undoubtedly called for in order to supply the proper amount of fuel required.

The work of afforestation must be done gradually

192 I am far from advocating the covering of the country all at once with village forests Whatever is done must be done carefully, and at first experimentally, even where a large area of land is available, it may be better to take up only a portion at first and to extend it if successful. But the plan should be given, what it has not yet had, a fair trial.

Enquiry is needed to ascertain areas suitable.

By enquiry alone can it be ascertained whether there are any purchasable areas, and whether they would be suited for the purposes contemplated No general rule for purchase can be laid down, all depends upon where and what the land is, and what it costs

Estimate of cost of land purchased.

193 Where land has to be purchased, it is recognised that, as soon as this fact is known, absurdly high prices are asked, although the land may be bringing in next to nothing.

The estimate of the North-West Provinces Government was, that, so long as land did not cost above *Rs* 20,000 for 10 square miles or a little above *Rs.* 3 an acre, it would pay to buy it, and, as has been stated, when Messrs Wilson and Darrah came to enquire, they found far more land available and purchasable within the price fixed than had been expected Further, they found that the financial prospects were fair, even after making calculations unfavourable to the scheme The estimate of cost, it should be said, included that of fencing with stone uprights and barbed wire.

In the North West Provinces there is almost any quantity of salty land (*usar*) available, but its frequent occurrence amidst cultivated land adds to the cost of purchasing blocks which include cultivation, and to the expense of enclosure which would then be necessary. Still, there are many tracts which are entirely *usar* land.

In the Central Provinces Government is generally able to purchase unculturable land at 1 rupee per acre, and culturable though uncultivated land at *Rs* 2 per acre, so that here, where cultivation has not as yet pressed on the land the problem of obtaining land for "fuel and fodder reserves" is not a difficult one

That land could be taken up at this rate and worked profitably there can be little doubt, judging from the experiments in the North-West Provinces, where the purchase price was *Rs* 3 an acre

194 Some practical details may now be mentioned in the working of those "fuel and fodder reserves" which will have to be *created*, either by the taking in of waste land or by the purchase of fresh land — Practical details in working of fuel and fodder reserves

The area to be taken up should not be too small, a minimum of 100 acres, or possibly 200 acres, should be fixed, unless there are a number of small blocks close to one another, for which one and the same supervision would suffice There is not, I think, need of permanent enclosure or fencing, and guards (*chowkidars*) should suffice for the purpose Even should a stray animal find its way in occasionally, the harm done will not be great, and the owner would be liable to have his privileges forfeited if the act were repeated — Size of area. Enclosing not requisite as a rule

Even if enclosure were found necessary it would be quite feasible to enclose a portion at a time, and by growing a live hedge behind the protection of a barbed-wire fence the latter could be moved on as the hedge became established. In this way successive areas of 20 acres at a time might be taken up, until the whole "reserve" was formed. It is only where small blocks occur in the midst of cultivation that the necessity of fencing is likely to arise, and then a small mound and ditch will answer best, unless it be where thorn *babul* cactus, prickly pear, aloe, *euphorbia*, or other hedge material will grow readily

Aloe hedges and earth walls occur near Mysore, stone walls are used in the Deccan, at Dumraon a hedge of *euphorbia* enclosing 15 acres of land took three to four years to establish itself properly, and the cost of throwing up an embankment all round the area, and planting the hedge was *Rs* 53 only — Cost of enclosure when requisite

At Gursikran near Aligarh, 718 acres of salty land (*usar*) are enclosed merely by a small ditch and low mound, and the cattle do not get in at all Mr W. B Hudson gave me particulars of some enclosing which he had done He made a ditch with sloping sides 6 feet wide at the top and 2 feet at the bottom, the earth being thrown up to form a bank on the top face of which thorn is planted The whole cost was *Rs* 5 per 100 yards, or *Rs* 88 per mile In Messrs Wilson and Darrah's experiments stone uprights and barbed-wire were used and the cost was 1 rupee per 9 feet (*Rs* 587 per mile), or as much as *Rs* 6 6 per acre for enclosing a block of 200 acres extent Major Wingate at Mian Mir, Kohat, and other places, has, however, carried out ditching, banking, and hedging at much lower rates than those stated in the Report of Messrs Wilson and Darrah

In Messrs Wilson and Darrah's experiments it was necessary to entirely enclose the land but in the case of a "fuel and fodder reserve" the entire charge of fencing etc, might, I think be replaced by guards (*chowkidars*), at a salary of *Rs.* 2½ per month each.

be passed to lay the obligation on the proprietor to grow firewood, and to preserve these supplies for the common good

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should be cut in rotation or not, and other points They are questions for the Forest Department to decide upon

In some parts it will be possible, as has actually been done in the Central Provinces, to have a village committee or *panchayet* to manage among themselves the internal arrangements, under . . . to this *panchayet* the . . . the case, too, of villages . . . ample set and decide to turn their village waste into a "reserve," the working of it through a *panchayet* would be a good plan In the majority of cases it will, however, be found that the "reserves" will, at first at least, have to be worked practically by Government, and in this matter, as in the kindred instances of tea and cinchona, the Government will have to *initiate* the work, and then they may withdraw.

Village committees

Government will have to initiate the work

195 As to the financial prospects Taking, for example, an area of 500 acres, there would be the purchase of the land, say 1 rupee per acre, the cost of planting and maintenance, and, as annual charges, the interest on *Rs* 500, say at even 6 per cent, * together with the wages of two guards at *Rs* 2½ each per month, say *Rs* 60 per annum . . . e per householder would, in all . . . without pressing in any way und . . . them very cheaply with wood, fuel, and grass

The financial prospects.

But as I have indicated before, it is not the question of actual return alone that has to be considered It is also the well being of the people, and the maintenance of the soil's fertility. In no way can these be better secured, and the Land Revenue to the State be e . . . he people as fuel, and thus . . . on the land It is not, the . . . ed purely by the direct financial return, but is one the utility of which must be judged by wider considerations, such as, that, if it be neglected, it may imperil the fertility of the soil, the prosperity of the people and the wealth of the country.

The financial return not the sole consideration.

A good deal of this work may be considered as "protective" in character, and may be carried out as a measure of relief in times of scarcity or famine, and be paid for out of the "famine fund"

Relief work.

196 In this connection I . . . profits obtained by the Fores . . . present they do simply to sw . . . a portion of them should be d . . . supply of wood for *agricultural* purposes Outlay will certainly be required, if the scheme is to be realised, and it would be only right that a portion of the profits should be set aside for a work having such an important bearing on the welfare of the country at large

* This is probably unnecessarily high 4 per cent might be sufficient.

CONCLUSIONS

197 In so far as the differences which exist between the agricultural conditions and practice of different parts arises from varying facilities for the supply of wood, an improvement in agriculture may be expected to come from a modification of these differences Such modification can be effected by increasing the supply of wood more especially of firewood, to those parts which are *insufficiently provided with it* *The task of doing this is one* clearly beyond the reach of the people, and it is to Government that they must look for help It is possible that in some cases the people will follow, in a small way, the example set them, but the duty is one which Government must take upon themselves, just as they have done that of the supply of water

The provision of wood as fuel, to take the place of the cow-dung at present so largely burnt because wood is so scarce, is the only practical way to ensure the sufficient manuring of the land, and the keeping up of its fertility If this be not done the State must be prepared to meet a diminution in the revenue derived from the land, and a decrease in the prosperity of the cultivating classes

There is no doubt that forests have been destroyed, and that cultivation has been pushed on without sufficient reservation of land for the supply of fuel The Forest Department, happily, has stepped in to prevent the further destruction which the people, if left uncontrolled, would have continued to carry on Originally the duties of the Forest Department were non agricultural, and consisted in the preservation and development of large timber forests The success was judged from the financial standpoint alone In later times, however, cultivation has spread nearer to the large forests, and wooded tracts have been reserved among existing cultivation This has called for a change in the policy of the Department, and its functions have necessarily become more agricultural Much good work has been done by the Department, but it is still necessary to extend it in a more agricultural direction than before The forest "reserves" in Ajmere Merwara afford a good example of what can be done, and of the policy which should be adopted on an extended scale After reviewing the existing supplies of wood, it is evident that the requirements of agriculture are very insufficiently met and that the creation of further supplies throughout the country is urgently called for The establishment of "Fuel and Fodder Reserves" is the most desirable form in

which effect can be given to this recommendation Such "reserves" should be primarily adopted to serve agricultural ends There is a considerable amount of land which might be taken up for this purpose In some cases Government waste land is available, in others land must be acquired by purchase The results must not be gauged by financial considerations alone, but by the benefits conferred on the agricultural population, the keeping up of the soil's fertility, and the maintaining of the Land Revenue to the State Enquiry is needed in order to ascertain exactly what the requirements of each district are in respect of fuel, etc, and how these may be met. Continued encouragement should be given to the spread of Arboriculture. The Forest Department is certainly undermanned, and the present financial check placed upon its further development in an agricultural direction should be removed

RECOMMENDATIONS.

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198. I recommend:—

The creation of fresh "Reserves" of wood, fuel, etc. ("Fuel and Fodder Reserves"), primarily for agricultural purposes.

The increase of Plantations along canal banks, railway lines etc.

The further encouragement of Arboriculture

The establishment of Agricultural Enquiry to ascertain the requirements of each cultivating district in the matter of wood supply.

The setting aside yearly of a portion of the Forest Revenue, to be applied to the extension of "Fuel and Fodder Reserves" to meet agricultural needs.

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CHAPTER IX

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Grass

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Grazing.

Grazing areas in distant forests

199. The subject of grass supply is closely connected with that of the foregoing chapter, inasmuch as the forests provide the principal grazing areas, and the "fuel and fodder reserves" afford a certain amount of grass for cutting. Included among the more distant forests are large pasturage areas, the value of which for this purpose has always been recognised, and which, on this account, have never been broken up. To these tracts professional graziers and hereditary castes of cattle-breeders resort, taking with them from the plains the most valuable of the *raiyats'* cattle, for the purpose of seeking shelter and pasture for them during the hot season. The retaining of these areas for the purposes of cattle-breeding is very desirable; it is, however, not the actual cultivators who directly make use of them, but particular castes who make this their special business, and who often bring cattle from a long distance. It is in these grazing areas that the bulk of the native butter called *ghi* is produced.

Grazing in reserved forests

200. In addition to the pasturage provided in the open and more distant forests, there is another class, but still distinct from the village "waste" or common land to which I shall refer later. This class comprises the grazing areas belonging, or which till recently did belong, to villages or individuals, but which are now included in the "reserved forests." In the Bombay Presidency (where these areas for the most part occurred) the land was known as *gairán* or "grazing," *i.e.*, land set apart for grazing cattle. It differs from the "waste" immediately around the villages in being really useful for the purpose, whereas the latter, as a rule, is little more than bare ground. The Forest Department frequently found it necessary to take in these lands when forming their "reserved forests," and in Bombay, according to the new grazing rules of 1890, the term *gáirán* is to cease, and free grazing is to be provided in the open part of the forest for the "agricultural cattle" of villages which have contributed *gáiran* to the formation of a forest block. These areas are let out, and communities often combine for the right of cutting grass in them.

Gairán in Bombay

Forest revenue from grazing land.

The Forest Department derives a considerable income from the foregoing grazing lands, and in looking at the Forest Revenue it is well to bear this in mind, and to remember that, whereas formerly the returns derived from forest pasture land were included in the general Land Revenue, they now go to swell the Forest receipts.

201 The provision of grazing in "reserved forests" is at once a desirable and legitimate object by which the interests of cultivators may be served I would repeat Sir D Brandis' note, quoted in the last chapter — *Provision of grazing in forests desirable*

[illegible] *Sir D Brandis' opinion, 1883*

The Madras Resolution of October 1890 concurs in this expression, and affirms that the provision of pasture, small timber, fuel and leaves, is the chief object of the "reserved forests" throughout the greater part of the Madras Presidency (*see* paragraph 175). *Madras Resolution, 1890*

The importance of the forests in time of drought is very great The Government of India's Resolution of March 1883 pointed out [illegible] crops would not replace grazing [illegible] (except in the few secured tracts [illegible]) the fodder crops would fail too The service done by grazing areas in the famine of 1878-79 has been referred to in paragraph 163 During the last Mysore [illegible] rs having no place [illegible] the cattle involved [illegible] a loss of manure to feed the subsequent crops Had there been throughout the country such "fuel and fodder reserves" as I have been suggested in the last chapter, many valuable cattle would, undoubtedly, have been saved. *Importance of forest grazing in time of drought*

202. But, notwithstanding the benefits which "reserved forests" and "fuel and fodder reserves" may afford in *exceptional* times, I cannot regard the provision of grazing in "reserves" as an *absolute necessity* in *ordinary* times It is a desirable purpose for the "reserved forests" to serve, if it can be [illegible] say that I consider the provision of fuel to be of the greater importance, and that it would, as a rule, be better to have the grass cut than grazed by stock *Provision of grazing not an absolute necessity in ordinary times*

203 When, without interfering with the general purposes which a "reserve" is to fulfil grazing can also be permitted, well and good, but it must only be carried on under conditions which do not destroy the main utility of the "reserve" *Conditions under which grazing may be permitted.*

Where natural reproduction of trees is going on, grazing must, for a time at least, be altogether excluded If land is heavily grazed the soil gets hard, the seed that falls from the trees is eaten or broken, or, if it comes up, the shoots are trampled down The surface soil is rendered impenetrable to forest seeds, and trees can only be got to grow by means of planting In a forest where clearing is done by "selection" *Exclusion where natural reproduction is going on*

of trees over the whole area, reproduction is going on continuously, and grazing would always do harm. Often it is the case that the forest cannot be treated in any other way. But where it is possible to work it in blocks, then it may be quite feasible to admit grazing in special blocks at a time. There is, of course, the difficulty of preventing cattle, when admitted, from straying over the whole area. This I noticed to be the case at Etawah (*see* paragraph 181). The people having complained about being shut out from grazing, they were allowed this privilege in one part of the "reserve." However, they abused the concession, and when I visited Etawah I found cattle straying over other parts than those in which grazing was permitted.

The Madras Resolution of October 1890 says on this point:—

"The working plans for the 'fuel and fodder reserves' should contain "proposals for throwing open certain areas to grazing, while keeping others "closed against all herds."

Sir D. Brandis' opinion. The necessity of restriction was recognised by Sir D. Brandis. He held that during the first few years some restriction in grazing must be entailed in the formation of new "reserves." He said:—

"At first protection must be absolute, but meantime the grass that grows "up abundantly can be cut and supply fodder till the forest is sufficiently "advanced to admit of grazing."

Unwillingness of forest officers to provide grazing. 204. Restriction in grazing sometimes arises from the unwillingness of forest officers to provide it, sometimes from the past bad treatment of forest land by the people rendering restriction imperative. On the Shahdara (Lahore) plantation the space for grazing is confined to the portion which is about to be cut over in the then year, or year following. Even to this the forest officers object, saying that grazing makes the soil hard, and prevents the shoots from coming up afterwards, whilst, if the cattle were allowed among the medium sized trees, they would get at the boughs. I fear that where wood growing is *the* object there will always be considerable difficulty placed by the forest officials in the way of providing grazing facilities.

Restriction of grazing called for by bad treatment of forests in the past. At Salem, which used to be a great cattle breeding district and noted market for stock, I heard great complaints that since the forests had been "reserved" the people could not keep so many cattle, and only had their own fields to feed them on, whereas formerly they had free grazing rights in the "reserves" two miles off. Grazing was still allowed, but it was at a minimum in consequence of the way in which, by excessive grazing, the "reserves" had been treated in the past.

The number of cattle must be restricted. 205. It is not enough to confine grazing to particular blocks at a time, but the number of cattle admitted must also be limited, for unrestricted grazing is fatal, and is the chief cause of the many bare plains and hill sides that are to be seen in India.

The Government of India's Resolution of March 1st, 1883, pointed out that:—

"The cultivated area had increased at the expense of the grazing area, "and uncultivated land had been rendered bare and unfertile by unrestricted grazing of sheep and goats, causing vegetation and scrub to "disappear, as in Scotland

Cheviot Hills.

The latter reference is to the Cheviot Hills, which have long been the resort of breeding flocks of sheep These flocks have removed a great deal from the soil, and, in particular, phosphate of lime, so that now the hills do not carry the amount of stock that they used to.

Action in Madras

The Madras Government, in their Resolution of 1890, made provision that the cattle required for agriculture and for domestic purposes should have the first claim on the Government "reserves," and that surplus cattle should only be allowed when circumstances permitted The grazing rates for agricultural cattle were to be one-half those for others.

Action in Bombay

In the Bombay grazing rules limitations have been imposed on the number of cattle allowed to graze, and the order in which the privilege may be exercised has been determined. This has led to a difficulty as regards the definition of the term "agricultural cattle," inasmuch as, according to the Forest Department's interpretation, milking-cows, buffaloes, and cattle used for transit would be excluded, and only such cattle as are used in the plough, or are worked at wells, would be included. This close definition does not appear to me at all a fair one, and the permission should certainly be extended to all cattle which the cultivator keeps for *bonâ fide* agricultural purposes.

Agricultural cattle

Restriction as to kind of stock admitted

206. Next, there must be restrictions not only as to the *number*, but also as to the *kind* of stock admitted to grazing Comparing cattle with sheep or goats the former are decidedly preferable, sheep and goats eating much more closely, and doing far more damage to trees and shoots Goats, there is little question, are highly objectionable animals to have in a forest, the destruction they do to young trees by climbing up and pulling down the branches, and often whole trees, cannot be contested, besides, they eat off the bark and kill the young trees I quite agree with suggestions made, that goats must either be excluded from forests altogether, or else be only allowed in a special part demarcated for the purpose The rearing of goats is not one likely to be given up, and where it is an important industry it may be necessary to mark off special areas for their use, but, speaking generally, as their presence in a forest simply means ruin to it, they must be excluded Both in France and in Germany it has been found necessary to altogether prohibit grazing by goats in forest areas.

Grazing by goats objectionable

According to the Bombay grazing rules, only one goat is let in to graze to every 50 sheep, there being an idea in Bombay that sheep will not graze unless led by a goat. In both the Bengal and the Madras proposals for the formation of "reserves" goats are excluded entirely from grazing, except in areas set aside for

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them Camels may be classed with goats as being equally destructive, but sheep graze more than they browse, and are not nearly so bad as goats, for they do not climb up nor tear down the branches cf trees.

Other restric tio s

207. Free grazing by cattle should never be permitted if it can be avoided, and the system of payment per head of cattle admitted is very preferable to that by area grazed.

"Close" season

I . . "close" season, when . . . ortunately, may come . . the forests most useful. Thus, in April and May there is great danger of fire, owing to the dry nature of the grass, and people coming in w th cattle and kindling a light may easily cause great destruction to the forest. In June and July, again, there is no growth of grass, and to admit stock to the forest then is often to destroy it altogether for the future. Of forest fires I have spoken, and the damage they . . 'at, although a temporary growt . . of setting the dry coarse grass (. . at loss to the forest (*see* paragraph 164).

Cutting of grass i reserves is prefer ble to grazing

208. Unless where distant forests are concerned, or where "reserves" are sufficiently large to permit of grazing, I am in favour of grass being cut and removed rather than of its being fed off by stock At *ruth* Jelleke (near Changa Manga) the people pay 1 rupee for the privilege of cutting and removing one head-load of grass each day during one month At the Etawah "reserve" the grass is cut by a contractor, and is sold on the spot for ¾ anna per head-load of about 100 lbs ; this is sold at 2 annas in the village, and the price in Cawnpore is [illegible] *pertusus*), a . . . used for th . . . making bedding ropes, and paper, also grow well. The quantity of grass being beyond the requirements of the village, a scheme was set on foot to get hay presses and to send the pressed hay to Cawnpore A great deal of the grass is, indeed, wasted This leads me to remark that in the case of an over abundance of grass there is no reason why it should not be made into hay and stacked, or, if the weather . . n into pits simply dug in the g . Either of these plans would times of scarcity would be invaluable.

Surpl s of grass sl o ld be made i to hay or else into silage

The village waste

209. Passing now from forests to the common grazing grounds of villages, the village commons, or, more properly, the village "wastes," I may say at once that I regard these simply as so much standingroom and "as exercise grounds." As for providing any herbage, they are, except perhaps just when the rains come absolutely useless and the existence of them is only an invitation to keep so many more half-starved cattle than the land can carry They are instances of the destruction done by over-grazing, for, no sooner does a blade of grass show itself than it is nibbled off, and the place is soon left bare

Mr. Sen, writing of Burdwan (Bengal), says —

"The system of cattle grazing—and it is the same all over Bengal—"is most wasteful, cattle roam without restriction, the grasses have no "opportunity to grow, and it is a struggle for existence between them and "the cattle."

T [illegible] grazing ground is nothing more [illegible] I have frequently examined these [illegible] rally found them to be bare during the cold and the hot seasons, and during the rains to have little more than a covering of *annual weeds*. Such was the case, for example, at Baroda. At Nadiad, where the cattle were well cared for, I found that the cultivators did not use the village common at all. Their cattle were fed with the grass grown as a border round their fields, and on the village common were only the cattle belonging to tradesmen and others in the town, but not those of the cultivators.

But there is a more serious side to this matter of the "village waste." Were its influence merely negative, one might stop here, but there is no doubt that these bare open spaces are often productive of positive harm. Not only do they permit of hordes of miserable cattle being kept on them, but the number of the latter is constantly being in [illegible] wretched as the oth [illegible] ing of these cattle [illegible] until death comes, [illegible] the latter appears it makes short work among animals so little prepared to resist it, and the "village waste" becomes a hotbed of disease, and a *nidus* for spreading it over the country around. The impossibility of segregating affected cattle while these "village wastes" are open is one reason for the enormous loss of cattle by disease which takes place in India.

Frequently a source of harm.

The only way to render these "wastes" useful would be to enclose them and then let only a limited number of cattle in. It would be possible to show the people what effect enclosure, even of a strip, would have, but the village common, as shown in the last chapter, is a difficult matter to interfere with, and, except where the area is more than the village requires, Government could not well step in and take up the land. In some parts, as in Kapurthala (*see* paragraph 178), the people may spontaneously follow the example set them of planting trees but this must be left to them, although much may be done in giving them encouragement to do so.

How to make the village waste useful.

210. Canal banks and plantations afford, in some cases, grazing or a supply of grass for cutting. Along the canal banks near Cawnpore no cattle are allowed, but the grass is cut and removed; between Hurdwar and Rurki grazing is allowed along the canal banks, it is let for from Rs 20 to Rs 50 a mile, to the highest bidder, without limit as to the number or kind of cattle. Grazing along the Eastern Jumna Canal is confined to the village that

Grazing along canal banks and in plantations.

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Surplus of grass should be made into hay or else into silage

The "village waste"

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acres of grazing for 9,000 acres of cultivated land, but now the former is diminished to 250 acres. I have made many enquiries to ascertain whether cattle are dependent on having grazing or not, and, though it may, undoubtedly, be a great advantage for them to have it, I do not find grounds for regarding its provision as an absolute necessity, nor does it appear that where grazing is the most plentiful the best cattle are always to be found. In Bengal, for example, there is grazing in abundance, but the cattle are poor and small; in Champarun (Behar) there is plenty of grazing, and [illegible] the worst of any in Behar. [illegible] yet the cattle are splen- [illegible] grass is plentiful, but the cattle are very small, though buffaloes are, by way of contrast, very fine. *Instances.*

Mr. Fuller tells me that in the Central Provinces the worst cattle are found, as [illegible] This is the case [illegible] there are rice lands. [illegible] tisgarh. The one exception is the Balaghat division, here the main crop is rice and there are no village grounds, but the soil is good and all the cattle are stall-fed. Pulse crops are grown along the top of the embankments of the rice fields. In the Punjab generally there is little grazing at the command of the cultivator, but the cattle, fed as they largely are on fodder crops, are hardly anywhere to be found better, and are kept all the year round on the holdings, the buffaloes being the only animals that require to be driven to the forests or river sides in the hot weather. In the North-West Provinces and elsewhere cattle may be seen roaming over the fields after the harvest has been reaped and subsisting on apparently nothing, but with what they pick up and the straw chaff (*bhusa*) which is given to them, they manage to get on, and as soon as the rains commence the fields rapidly become covered with grass.

213. The next question is, Will the growing of grass ever form a part of the *raiyat's* ordinary cultivation? I do not think that it will. Here and there he may be induced to grow grass for the supply of military stations or camps, but these, especially the latter, are ever liable to be changed. At Belgaum fields are grown with grass, two cuttings are obtained yearly, and 6 annas is the sum paid for 100 lbs of green grass. No seed is ever sown, only [illegible] *raiyat*, as a rule, looks to his field to supply himself with grain and his cattle with fodder, and I cannot help thinking that he is right. Again, he could only grow a continuous supply of grass by the aid of irrigation, and he is hardly likely to afford this for his cattle alone. He may, and should, grow fodder-crops, but he will not, I think, grow grass. At Salem each cultivator used formerly to have a bit of pasture land which was given at the low assessment of 4 annas an acre. *Will the raiyat keep land under pasture?*

If this system were revived, the cultivators would again grow pasture In this district, where the sale of cattle is an important one, it might possibly pay, even now, to keep some land down to grass But the idea of making one part of the land feed the other is foreign to custom A large proprietor can set land apart for this purpose, but not a *raiyat* with an average holding of 2½ acres or so

Mr Nicholson says of Coimbatore —

"Occasionally grass is sown for pasture (*harali* and *kolei kattei*), it is kept "down some years and then ploughed up and re sown or other crops sown "Early in the century all the best lands were under cultivation, and only "inferior ones in grass Up to the time of the new Settlement (1880) the "tenant used to hold one fifth of his farm as pasture at one-quarter its "assessment and only changed to full rates when he turned it into arable "land This was abolished at the new Settlement"

Where pasture is urgently required, encouragement may be given to its formation by giving remission of assessment, but it is only exceptionally that the cultivator will put land in grass if he can grow another crop on it.

Grass Farms, Haymaking, Silage

Cantonment Grass Farms and military *rukhs*

214 I have visited several of the Grass Farms which are under the Military Department, and which are intended to supply grass, hay, etc, for the requirements of the mounted service My particular object was, to form an opinion as to whether grass could be grown, and either be cut and given green, or be made into hay or silage, so as to render it profitable to the *raiyat* to keep some of his land under grass The Grass Farms were the only ones from which I could obtain any definite particulars as to what had been done, and I have pleasure in acknowledging the readiness with which full information was given to me by the authorities. In addition to the Cantonment Grass Farms, such as those at Allahabad, Cawnpore, and elsewhere, there are the *rukhs* or uncultivated grass lands devoted to military purposes, these occur largely in the Punjab The word *rukh* originally meant a *tree*, this shows that these areas originally were *wooded* ones Now the word is equivalent in meaning to "grass run."

System started in 1882

215 Without going into descriptions of any of these Farms, I may briefly say that the system of enclosing grass lands for the purpose of supplying fodder to mounted troops was started in 1882 by Sir Herbert Macpherson at Allahabad, and since then has been extended largely, so that now there are two Circles, the Eastern and the Western, under which the different Farms and *rukhs* are included In the Western Circle, which comprises the greater number of *rukhs*, Major Wingate has been appointed Special Forage Officer. Previous to the introduction of the Grass Farm system, the practice had been to send out "grass cutters," whose duty it was to cut and collect grass for the troops from wherever

they could. As the grass chiefly came off the cultivators' fields, great friction was caused between the *raiyats* and the "grass-cutters," and serious fights often occurred. The former grass cutter system

In addition to the "grass cutters" for British mounted corps one "grass-cutter" was maintained between every two *sowars* or Native Cavalry soldiers, and a pony was kept for him. Pensions had to be provided for the "grass-cutters," and, altogether, their cost might be fairly put at Rs 5½ a month for each horse kept In addition, very considerable sums had to be paid to the Native Cavalry as compensation for fodder purchased in order to make up the short supply of grass obtainable by the "grass cutters"

The cost of hay is reckoned at 8 annas a maund (80 lbs), and that of feeding a horse, at 2 annas a day, or Rs. 4 a month, besides this, the *sowar* had to feed himself, and along with another *sowar* maintain one "grass cutter" and a pony between the two of them. If the "grass cutter" could not get sufficient grass, then fodder had to be purchased The Government scale of reckoning at Allahabad was that 35 maunds of green grass, or 40 lbs of silage, were equal to 25 lbs of hay or 20 lbs of straw-chaff (*bhusa*). If the monthly cost of the rations exceeded Rs 13½, then compensation was paid to the Native Cavalry at the Government rate.

216 Owing to a full supply of grass being now obtainable by the "grass cutters" from Government grass lands, not only have a large number of the "grass cutters" of British mounted corps been dispensed with, but the claims for compensation for dearness of forage which used to be paid to the Native Cavalry have lessened very considerably at nearly all the Stations, and have ceased altogether at several of them. In 1889-90, payment of compensation had entirely ceased at six Stations in the Western Circle Great saving has further been experienced by the reduction in the number of pensions to be paid to "grass-cutters" Thus, not only is there an actual money saving, but troubles with cultivators have been stopped, the horses are believed to be less subject to anthrax (the grass no longer coming from unprotected and suspicious sources), and the Stations have been much improved the covering of grass having prevented the blowing about of dust A more healthy state of surroundings is also produced by the growing of grass instead of that of ordinary crops, which latter would in almost all cases have to be irrigated. Changes effected by the Grass Farm system

217. The result of the operations shows that a very large saving to Government has resulted from conserving the grass lands of Cantonment and military *rukhs*, and the system is one that ought to be extended wherever practicable. Allahabad has, perhaps, been the most conspicuous success, and besides the great credit due to Sir Herbert Macpherson, to Colonel Marriott and other officers who have been successively in charge, special mention should be made of Sergeant Meagher, who has shown much energy and ability in carrying The financial result

out the practical part of the work The saving to Government at Allahabad in 1889 90 was estimated at Rs. 26,000, and for the seven years, 1882—89, at Rs 91,158, in other words, these are the sums which Government would have had to pay had the usual rations of straw-chaff (*bhusa*) been issued to transport and other animals, had full complements of "grass cutters" been maintained for British mounted corps, and had compensation been paid to the Native Cavalry for fodder purchased to make up the "grass-cutters'" short supply of grass

The amount of grass grown at several of the Stations, including Allahabad, has been so increased that it is now possible to supply not only the British troops, but also the Native Cavalry with it.

It is, however, with the *actual cost* of the operations of cutting, haymaking, and ensiling that I have mainly to do, though, I should add that, in making any critical remarks, it must be remembered that in most of the Stations the operations are still in their infancy.

The cost of haymaking in India

218 The great difficulty on the Grass Farms is the employment of sufficient labour, and hence, to anyone with ideas of cheap labour in India, the cost of haymaking, etc, will appear very high for that country I am also prevented from instituting the full comparison I wished to make because the profits stated are not the *actual profits* of the Farms by sale of produce in the open market in competition with private enterprise (representing what is actually over and above rent, cultivation, etc.), but the returns are merely comparative, *viz*, as to what Government *would have had to pay* if the Farms had not existed So I must content myself with giving a few items and making a few suggestions

It is generally reckoned in India that from 2½ to 2¾ tons of green grass will yield 1 ton of hay At Allahabad the amount is 67 maunds (of 82 lbs) of grass to 1 ton of hay

The following table gives the cost of cutting and haymaking, etc, at Allahabad and other Stations —

TABLE XII Cost of Cutting Grass and Making Hay at Grass Farms

——	Per Maund (80 lbs) of Hay made	Per Ton of Hay made		English equivalent taking the Rupee at 1s 6d		
	Annas	Rs	a	£	s	d
Allahabad 1889 89 —						
Cutting grass 1 anna per maund	2½	4	2	0	6	3
Making stacking and thatching hay	½	1	2	0	1	8
Total Cost of Haymaking	3	5	4	0	7	10
Cawnpore 1890 ditto ditto	4	7	0	0	10	6
Ha e y 1890 ditto ditto	5	9	0	0	13	6
The Punjab generally, (according to Major Wingate) ditto ditto	4	7	0	0	10	6

Rate for cutting grass

From 1 anna to 1½ annas per maund (80 lbs.) of green grass may be taken as the general rate for cutting

219 In the comparison which I shall make I purposely take the Farm where the operations have been longest practised, *viz*, Allahabad, at the same time, the cost here is the lowest Comparison with cost of haymaking i Eng and

Unmanured land at Allahabad is reckoned to yield about 48 maunds, or somewhat less than 2 tons of green grass to the acre, but by using manure (night soil and town sweepings, *see* paragraph 143) the yield has been increased from an average of 2 tons of green grass per acre in 1883-84 to one of 5¼ tons, or about 2 tons of hay to the acre over the whole Farm. The extent of the Farm is 3,558 acres in all

The yield of grass per acre (5¼ tons) is not unlike what ordinary good land would give in England, but this is the average over the whole of the Allahabad Farm, there being only sufficient manure to supply it to portions in turn Where a heavy dressing of manure is newly put on, as much as six crops of grass can be got in a year, five being cut for feeding green and for silage, and the sixth for hay, while for five years the manured land will keep on producing an average of 22 1/7th tons of grass per acre yearly

To compare next the relative costs of cutting grass in India and in England In England 1*s* an acre for cutting by machine, and 2*s* 6*d* per acre for cutting by hand, are prices frequently met with

The yield of hay per acre in England is from 1¼ to 1½ tons, as against the 2 tons per acre at Allahabad, so that the cost of cutting would at most be only 2*s*. a ton in England as against 6*s* 2*d* in India A rate of 6*s* 2*d* per ton of hay, for cutting alone, must be considered enormously high in a country of cheap labour like India, where an agricultural labourer, one may say generally, can live quite happily on 2 annas (or about 2*d*) a day Cutting of grass mo e expens ve in India

The total cost of haymaking in England will vary much according to the crop, its weight, etc, but 10*s* *an acre* all round, giving from 1¼ to 1½ tons of hay, may be taken as a fair average in the case of grass like that met with in India This would give a total cost of from 6*s* 8*d* to 8*s* *a ton* of hay, as against the 7*s* 10*d* per ton at Allahabad

We are obliged, therefore, even when taking the most favourable estimates, *viz*, those of Allahabad, to conclude that, at present, haymaking on Grass Farms in India is a dear process, the expense of cutting being the main cause Besides, there is not the difficulty and expense of turning the hay which is met with in England, for in India the hay practically makes itself Hay making at rass Farm s too expens ve

220. When rent and other charges are reckoned the cost of production of grass at Allahabad is stated to be Rs 3 As 10 per ton, and of hay, Rs 10 (say 15*s*) a ton The grass is estimated to be worth Rs 7 per ton, and the hay Rs 20½ (say 31*s*) This, it is true, is merely an estimate based on the fact that, if the hay had not been there, it would have had to be replaced by straw-chaff (*bhusa*) bought The estimated value of hay.

from contractors at the current rates of grass supplied by "grass-cutters"

This value is too high

The estimated value of hay, 31*s* per ton, and for such hay, or rather dried grass, as is obtained, is much above the real value, and is very apt to lead to misapprehension, for, if the *raiyat* could get anything like that sum for growing grass and for haying it, he had better lay out his land for it at once wherever sale of hay is possible A fair value to put on hay in India is from 8 to 10 annas per maund (80 lbs), which makes it Rs 14 to Rs. 17 a ton (say 21*s* to 26*s*)

These estimates, as I have shown, do not enable one to judge whether grass farming *pays as farming* independently of sale to Government at comparative rather than competitive values However useful, therefore, Grass Farms have been in the past, and whatever large economies have been effected, there is ample room for great economy still, if the cost of cutting grass and of making hay be considerably more in a country of cheap labour than it is in one of dear labour like England.

Pressing and baling of hay for camp

221. The experiment has been tried, and at times with success, to press and bale hay for transport to camps Thus, for the Muridki camp in 1889, grass was cut from two *rukhs* at Mian Mir, and from the forest plantation at Changa Manga Bales of hay, weighing 60 lbs each, were made, and altogether 18 500 maunds of hay were delivered in camp, at a cost of 9 annas a maund (80 lbs), which included 2 annas for carriage. The then price for loose dry grass in the camp was Re 1 As. 4 per maund, and a saving of Rs 9,000, or over 100 per cent, was thereby effected in the expenses of the camp. Besides this, if there had been less grass, and consequently a greater demand for it, the price current would have gone up, and even a larger saving would have been shown As regards the hay sent from Changa Manga, the experiment was carried out by the Forest Department and 5 075 maunds of baled hay were forwarded to the Muridki camp The grass cost 1 anna a maund to cut, and at first 2 annas, then later 3 annas, per maund to make into hay After baling and all other expenses had been paid, the Forest Department, by receiving from the camp 7 annas a maund for the grass (exclusive of carriage), realised Rs 2,190 by the sale, and made a profit of 1 anna 3 pies on every maund, or 33 per cent on the outlay. Not only this, but, after arrival at Muridki, the Commissariat Department, as we have seen, made a saving of over 100 per cent. in the camp expenses under this head

Experiment at Changa Manga

The result of the Changa Manga experiment may be summarised thus —

Cost of 5,075 maunds baled hay, delivered at Muridki, at 10 annas 5 pies per maund . .	Rs 3,251
Cost of dry grass at Muridki, at price current, 1 rupee 4 annas per maund . . .	6,344
Saving by the experiment . .	Rs 3,093

When I add that, on account of the difficulty of getting labour, the Forest Department ask now to be relieved from the trouble of continuing the work, and that the Commissariat Department say that they cannot get hired labour to send to cut the grass, it must strike everyone with regret that such an undertaking, yielding 23 per cent profit to one Department, and effecting a saving of over 100 per cent to another, should be stopped.

In another case, hay was made on *rukhs* Katlakput and Chandra, near Lahore Altogether, 1,147 maunds of grass were cut, and the hay was sold at Katlakput without being baled In all, 952 maunds of hay were sold at 6 annas per maund, and the account stood thus —

	Rs
Total cost (including carriage from Chandra to Katlakput) . .	235
Cash received, at 6 annas per maund . . .	357
Profit	Rs 122
	or 51 per cent

The requirements of camps are, of course, exceptional, and a continuous demand for grass supply may not exist, without this, it is probable that the undertaking might not be a paying one from year's end to year's end

Nevertheless, Changa Manga might always be used for supplying hay to Quetta, to which Station 2 *lakhs* (2,00,000) of maunds of straw chaff (*bhusa*) are annually sent from Amritsar A great saving would be effected if hay were sent instead from Changa Manga The Forest Department says '
for forestry and not for grass cutting, an
result of the Changa Manga experiment
the Department says that this was only so because it did the work itself, and in so doing left a lot of its forestry work untouched The work needed a lot of supervision and would only tempt local labour, this being insufficient for the purpose It is also stated by the forest officers that the greater part of the grass in the Changa Manga plantation is a coarse grass called *gharam* (*Panicum antidotale*), which the Commissariat will not use, even for litter When, however, I went to Changa Manga I saw a large amount of *anjan* (*Pennisetum cenchroides*) and of *chhimbar* (*Eleusine flagellifera*), both of which are capital fodder grasses, and might have made good hay or silage

222 The labour question is indeed a perplexing one, the main reason of the difficulty in procuring it is, that the people will not leave their own fields to come and cut grass, for labour is required just at the time that they want most to attend to their own crops This is at the end of the rains, when the lands have to be ploughed Cheap labour, too, is often very inefficient labour, and I have seen with positive annoyance near Mian Mir, coolies leisurely cutting grass with small sickles, while squatting down on The labour difficulty

the ground, the sickle in one hand and their pipe (*hookah*) in the other A cooly gets 1 anna for a bundle of grass weighing not more than 100 lbs, and, having cut that, he generally goes away. It is seldom that a man will stay to cut three bundles a day, and, meantime, thousands of tons of grass are going to waste The Cc T pay even more, *viz*, 1 anna 3 let out to a contractor I could t the great possibilities open, nd fair grass, too, were waiting to be cut, and would in the end be wasted The saving that could be effected to the country from this source alone would surprise any one who looked into the matter And, while I urge the extension of grass schemes for military purposes, as having proved a distinct saving already, it behoves the authorities to look much more closely into the matter of economy in the charge for labour, and to see if the difficulties cannot be met. I simply throw out a suggestion why labour is not procurable is, because the work is not continuous, might it not pay to keep up a regular staff to do this work, instead of depending on the occasional cooly who may choose to come and cut his bundle, get his anna and then go off?

The se of machine y upon Grass Farms

223 I would make another suggestion I am quite certain that over large areas, such as many of the Grass Farms and *rukhs* cover, an immense saving might be made by using mowing machines in place of cutting by hand I am not in favour of introdu-
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machine would effect great economy.

I have heard some of the Farm Overseers object to mowing machines, and to say that the grass gets knocked down rather than cut This however, I believe to be merely due to prejudice. It is true that a machine does not cut so closely as the Native's sickle does, and so the yield of grass will be less But mowing machines have been tried with success at Mhow (Central India) with a machine from five to six s by hand costs, on an average, on unmanured land, Re 1 As 13

I reas simple machinery for cutting Elevators for stacking hay would is no reason, either, why battery for drawing the mowing machines Another want is that of a portable press for compressing fodder Those in use at present are mostly "Boomer" cotton presses, and they are all of them too heavy What is wanted is to bring the presses readily to where the fodder is

Silage.

224. Ensilling, or the preserving of green fodder, has been carried out at Allahabad, Cawnpore, Hissar, Mian Mir, and, on an experimental scale, at other military Stations, also on Government Experimental Farms and elsewhere. The cost of making silage

[illegible]

latter. The loss of weight incurred in the process is surprisingly large, and the cost is so great that it would, in most cases, have been far more profitable to have made hay.

The following table will illustrate this :—

—		Grass ensiled.	Silage produced	Total Cost	Cost per Ton of Grass cut	Cost per Ton of Silage produced.	Percentage of good Silage.	Loss in ensiling
		Tons	*Tons*	*Rs*	*Rs as*	*Rs as*	*Per cent*	*Per cent.*
Allahabad	1888-89 .	2,187	1 231	5 850	2 11	4 12	56 28	43 72
	1889-90 .	2,324½	*1 072		1 1			
Cawnpore .	1888-89 .	560	170	721	1 5	4 4	30 42	69 58
Hissar .	1888 89 .	91	...	606	6 7			
	1889 90		...		3 2		..	...

* Estimate

Taking Allahabad in 1888-89, we have the following comparison :— Comparison with haymaking

2,187 tons of grass produced 1,231 tons of silage, costing to make Rs. 5,850, or 4 rupees 12 annas per ton of silage (as above).

If made into hay (2¾ tons of grass=1 ton of hay), 2,187 tons of grass would have given 795¼ tons of hay, costing to make Rs. 4,175, or 5 rupees 4 annas per ton of hay (as per table XII, paragraph 218).

Or, taking the figures of 1889-90 :—

2,324½ tons of grass are estimated to produce 1,072 tons of silage.

2,324½ tons of grass would have produced 940 tons of hay.

The value of hay being, as we have seen before, more than twice that of grass, it is manifest that, whichever year we take, it would have been very much cheaper to have made hay.

The grass has to be cut whether hay or silage be made, and this is the heaviest item in the cost. Owing to the time of year at which grass is cut for silage it costs less than when cut for hay. Thus, grass for silage is often cut at Allahabad for 6 pies (½ anna) a maund, but when cut for hay it will cost 9 pies a maund in September and October, 1 anna in November and early December, and 2 annas afterwards.

Until silage can be made with very much less loss and at much cheaper cost than in the instances given above, it is very certain that it will not be able to compete with haymaking.

Estimated value of silage

225 At Allahabad, silage is valued at 5 maunds (of 80 lbs) to the rupee which makes it 5 rupees 9 annas a ton or, in English equivalent, 8s 4d , a figure which, even in England, would be considered high

This estimate is based upon the cost of its production, but here, again the estimate is merely a comparative one, based upon what the Farm would otherwise have had to pay for purchased fodder, so that it gives us little guidance as to whether the ordinary cultivator would be justified or not in making silage

Other instances of the making of silage

226 The following are other instances of the making of silage —

Hissar

At Hissar where grass can be irrigated it is cut for silage, as it is found to be too coarse to make into hay

Mian Mir

At Mian Mir cutting of grass begins about the middle of August and goes on to the end of December there are four silos on *rukh* Terab, in each of which from 800 to 900 maunds of silage are made yearly

Ootacamund

I saw very good silage indeed in a silo on the Government Cinchona plantations at Ootacamund Fifteen and a half tons had been made at a cost of 4 rupees 4 annas a ton, this it will be noticed is about the same cost as at Allahabad and Cawnpore Earth to a depth of 4 feet and giving a pressure of about 400 lbs to the square foot was used to weight the silage this being I thought an unnecessarily large amount 1 foot depth of earth is quite enough for all purposes

Beheea

Messrs Thomson and Mylne make silage at Beheea, putting the grass into a pit simply dug in the soil

Belgaum

At the farm attached to the Agricultural Class at Belgaum there is a silo dug 16 feet deep in the soil, the sides being plastered with dung and well beaten

Bhadgaon

[illegible] the Bhadgaon Experimental [illegible] ggestion a silage [illegible] roads de cutti gs, [illegible] whole with stones,

Poona and Nagpur

At the Poona and Nagpur Experimental Farms silage has been made on a small scale

The quality of Indian silage.

227. I can speak very favourably of the quality of the silage produced at the different Farms and Stations mentioned above Its chief fault is that it is unnecessarily dry Of course the value depends mainly on the nature of the material used, and rich silage can never be obtained from poor material, although the process of ensilage may render coarse food more palatable.

The advantages of ensilage

228 One advantage of cutting an early crop of grass for silage is that there are many grasses, such as numerous species of [illegible] be secured as silage [illegible] being kept back some- [illegible] when the rains are over.

It may further be said in favour of silage that, by means of it, some grass, which would otherwise have been altogether lost owing to the heavy rain, is saved by being put into the silo.

229. It is, however, whe
of production, and examines t
time of putting in the grass
sees great room for improven
in India. I may, therefore,

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making hay. This I am ready to allov
extent only, for I have myself seen at
Mir, and other places, silage being made in large quantities when the weather was, and had been, as fair as possible, and when there was not the least excuse for making silage, indeed, what was going into the pits had been lying about and was really half-made hay already. I would insist strongly that this is a great mistake, and that, as I have endeavoured to show, it is false economy to try and make silage when hay can be made perfectly well.

To allow grass intended for silage to lie about is also wrong The essential feature of silage is that it is a wet or green food, therefore it should be packed in the silo as quickly as possible, be rammed down close, and covered over rapidly. If it is left about, it may just as well be made into hay at once.

I was reminded, when speaking in India on this point, that, in order to make so-called "sweet" silage, it is necessary to let the grass lie ab
partly dry,
not to troubl
get the gras
then shut it up closely, thus avoiding loss, and getting finally as much succulent green fodder as possible for use when all else is dried up.

partly to loss
tly to imper-
and, lastly,
to loss in taking out the material. Of the first I have spoken; as to the second, I am convinced that where a silo is to be a regular institution, and is not merely used for an occasional crop, it will pay infinitely better to have it made in brick-work or masonry (*pucca*) than to have a silo with earth sides and bottom (*kutcha*). The extra initial expense will soon be covered by the extra amount of fodder saved As regards the third point, I have noticed that, on taking out the silage, the usual practice is to remove the whole of the covering at once, and to leave the bulk exposed. This, again, is a great mistake, for the pressure

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Messrs Thomson and Mylne make silage at Beheea, putting the grass into a pit simply dug in the soil.

Belgaum

At the farm attached to the Agricultural Class at Belgaum there is a silo dug 16 feet deep in the soil, the sides being plastered with dung and well beaten

Bhadgaon

Silage has been made for several years past at the Bhadgaon Experimental Farm The silos are circular masonry pits At my suggestion a silage stack was made by simply building up green fodder, grass, roadside cuttings, etc, just as a haystack would be made, but weighting the whole with stones, or any other inexpensive material that was at hand

Poona and Nagpur

At the Poona and Nagpur Experimental Farms silage has been made on a small scale

The quality of Indian silage.

227. I can speak very favourably of the quality of the silage produced at the different Farms and Stations mentioned above Its chief fault is that it is unnecessarily dry. Of course the value depends mainly on the nature of the material used, and rich silage can never be obtained from poor material, although the process of ensilage may render coarse food more palatable.

The advantages of ensilage

228. One advantage of cutting an early crop of grass for silage is that there are many grasses, such as numerous species of *Panicum*, which seed in the rains these may be secured as silage if rain continues whereas the other grasses being kept back somewhat, yield a good hay crop about October when the rains are over.

It may further be said in favour of silage that, by means of it, some grass, which would otherwise have been altogether lost owing to the heavy rain, is saved by being put into the silo

229. It is, however, when one goes into the figures of the cost of production, and examines the actual loss of weight between the time of putting in the grass and of taking out the silage, that one sees great room for improvement in the methods of making silage in India. I may, therefore, make a few suggestions here

Improvement possible in methods of making silage

It is quite true that the real value of the process of ensilage consists in saving what would otherwise be lost, and hence it is not always fair to compare the cost of making silage with that of making hay. This I am ready to allow, but to a very limited extent only, for I have myself seen at Allahabad, Hissar, Mian Mir, and other places, silage being made in large quantities when the weather was, and had been, as fair as possible, and when there was not the least excuse for making silage, indeed, what was going into the pits had been lying about and was really half made hay already. I would insist strongly that this is a great mistake, and that, as I have endeavoured to show, it is false economy to try and make silage when hay can be made perfectly well.

Suggestions for improvement in the practice

To allow grass intended for silage to lie about is also wrong The essential feature of silage is that it is a wet or green food, therefore it should be packed in the silo as quickly as possible, be rammed down close, and covered over rapidly. If it is left about, it may just as well be made into hay at once

I was reminded, when speaking in India on this point, that in order to make so-called "sweet' silage it is necessary to let the grass lie about for several days after being cut, so that it may get partly dry but my advice to those who are going to make silage is not to trouble about whether it be ' sour " or " sweet " silage but to
s quickly as possible and
ss, and getting finally as
for use when all else is
dried up.

The great waste incurred in making silage is due partly to loss of moisture before the material goes into the silo, partly to imperfect pressing and the nature of the sides of the pits, and, lastly, to loss in taking out the material Of the first I have spoken, as to the second, I am convinced that where a silo is to be a regular institution, and is not merely used for an occasional crop, it will pay infinitely better to have it made in brick work or masonry (*pucca*) than to have a silo with earth sides and bottom (*kutcha*) The extra initial expense will soon be covered by the extra amount of fodder saved As regards the third point, I have noticed that, on taking out the silage, the usual practice is to remove the whole of the covering at once, and to leave the bulk exposed This, again, is a great mistake, for the pressure

should be continued as long as possible and the covering over the silage should only be taken off the portion which is actually being cut into for daily use.

Disagreement with views expressed as to India being the great country for silage

230. I have gone at some length into the silage question because I [illegible] f my predecessors, to t[illegible] e development of ensila[illegible] m much more ready to [illegible] exist over the greater p[illegible] be otherwise. Hay requires no making, for it makes itself Silage, I repeat, will only be useful when by means of it can be saved what would otherwise be lost.

The unsuitableness of mechanical appliances for the making of silage.

Still less do I think there is scope for any of the patent appliances advocated for "stack-silage" making The *raiyat* may possibly be shown how to preserve green fodder, roadside grass, etc, by building it up into a stack and weighting it with stones, timber, [illegible] where is he to find the money [illegible] been sometimes advocated, a[illegible] and even more? Such mechanical appliances may have a certain value upon large estates possibly, but surely none upon five-acre holdings

Experimental Farms should conduct trials on the making of silage

It becomes, however, one of the useful functions which a Government Experimental Farm can fulfil, to conduct careful trials upon different methods of making silage, and to ascertain how it can be made with the least loss, and in the most economical manner. Information may thus be gained as to the crops best adapted for ensiling, and as to the adaptability of the process to the *raiyat's* circumstances.

Suggestions for improvement in the management of Grass Farms

231 There are some points in connection with the management of Grass Farms wherein improvement can be effected The Station Farms are worked mostly by Grass Committees, of which the President and Secretary are the principal members, while a general supervision is exercised by the Commissary General of the Circle, aided by his Special Forage Officer, the Quartermaster General in India being referred to in all matters requiring the orders or approval of the Commander in-Chief.

Grass Committees

I cannot commend the Grass-Committee system. With President and Secretary constantly changing, it is most discouraging for a Forage Officer to work No sooner does a President or a Secretary get to know a little of the system at one place, than, as a rule, he is transferred to quite different work, and a totally new and inexperienced man is put in his place At Umballa the [illegible] be greatly lessened.

Farm overseers

In the next place, the overseers of the Farms are non-commissioned officers, temporarily withdrawn from their corps But they

are not properly selected, and care is not taken to choose the men who, from their previous acquaintance with the work, or from any aptitude shown for it, are the best fitted for the post of overseer.

At one *rukh* which I visited I found a farm overseer, with the very best intentions, making silage out of grass that had been lying about for several days The sun was then, and had been, pouring down with intense heat all the time, but the order had gone forth to make so many tons of silage, and he was doing his best to comply with it I asked him (though I felt the question was needless) whether he had ever made silage before, no, he had "never heard of the stuff before, until the order came" He was the station butcher! Such a man is to be pitied rather than blamed, but it does seem wrong that, where the field for economy is so large, it should not be better aimed at

Another ground I have for complaint is, that when capable men have been selected or after they have acquired some experience, their services are not retained at the work in which they have shown aptitude. A farm overseer, if he keeps to his work beyond a certain period, does so at the risk of losing promotion. He should be a permanent non commissioned officer of the Commissariat Department, "seconded"* in the departmental list, so that he may not lose promotion

The frequent changes in management.

This is, I fear, a fault of the entire Indian system, and is, thus, one hard to alter, but, in the interests of the country, I would strongly urge the desirability of retaining the services of *men for work in which they have shown special capabilities* Sergeant Meagher, of Allahabad, is such a man as this, and, knowing the energy he has displayed in the practical discharge of his duties, it would be a pity were his knowledge to be lost *to this branch of the Commissariat, or he himself lose promotion* by remaining where he is The saving which the Military Department might effect in matters of this kind alone would go a long way towards providing the funds required for the other "agricultural improvements' which I am recommending in this Report.

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* This term means that an officer while employed on work outside his legitimate sphere would still retain his departmental position and share in any promotion, reverting, at the expiry of his outside duty to his position in his Department

CHAPTER X.

FODDER CROPS AND HEDGES.

CHAPTER X.

FODDER CROPS AND HEDGES.

Fodder-Crops.

Fodder-crops

234. I[illegible] conclusion that the provis[illegible] while highly desirable, [illegible]

Fodder-crops not essential to *existence* of cattle

Nearly the same must be said of the growing of special fodder-crops. [illegible] cattle; [illegible] and care [illegible] extend t[illegible] cularly is this desirable where the provision of grazing is very limited, and possibly entirely absent. Nevertheless after enquiring into the matter with some care, I have not received more than the general reply that while cattle are undoubtedly far better for green food of some kind yet they can live quite well on dry food alone.

This coincides with my own experience in England.

Experiment at Woburn, England.

In an experiment which I carried out at the Woburn Experimental Farm a few years back, I found that bullocks, when fed on cake, meal, and hay, along with water supplied to them separately, but receiving no succulent food whatever, such as roots or grass, throve perfectly well, although the result of the feeding with hay did not prove to be an economical one.

Experience at Bhadgaon (Bombay).

At the Bhadgaon Experimental Farm (Bombay) experience has shown that cattle will do quite well on dry food during the hot weather, provided that they have a little cotton seed given to them.

Mr. Sabapathi Mudliar's experience at Bellary

Mr A. Sabapathi Mudliar, of Bellary, told me that he liked to give fodder-crops to cattle if he could, but that they would do quite well on dry food. For cattle in hard work, or for transit bullocks, he did not think green food so desirable. In time of famine, however, he had found the latter invaluable.

At other places also I heard the same opinion expressed, *viz.*, that fodder-crops were not so suited to *working* cattle. At the military Grass Farms there is a similar objection to the giving of silage to animals from which speed is required.

Experience at Grass Farms

Fodder-crops necessary for *improvement* of cattle

235. *It is one thing, however, to speak of a food not being* essential for the *existence* of cattle, but quite a different thing to speak of it being necessary for the *improvement* of cattle. This is where, I believe, the growing of fodder-crops will be required.

It is true, as pointed out in the last chapter, that the existence of pasturage is not always coincident with that of the best cattle, but yet instances were adduced where, as at Nadiad, Baroda, Hospet,

etc, the feeding of cattle with green grass from the headlands of fields, the banks of watercourses, etc., was pursued with manifest advantage.

The Punjab supplies the best instances of similar advantages derived from fodder-crops In this Province the people depend greatly on their cattle, and they take proportionate care of them. The district of Jhang is an especially good example, several kinds of crops being here grown entirely for the use of cattle. The Punjab cattle are, as the result, exceptionally fine. This exemplified 1 In the Punjab

The same is seen in Behar, when the cattle of the European planters are compared with those belonging to the native cultivators The former are fed with sugar-cane *judr* (*Sorghum*), oats, etc., as fodder, while the latter only have what grass they can pick up, supplemented by straw-chaff (*bhusa*). 2 In Behar.

The following quotations exemplify this still further — 3 In Kurnool.

Mr. Benson, in his Kurnool (Madras) Report, says —

' In the Cumbun and Markapur *taluks* where the soils are generally poor ... In the ... he *juar*

Mr. Nicholson, in his "Manual of Coimbatore, writes — 4 In Coimbatore

"Kangyam cattle are famous in Dharapuram *taluk* because of the extent "and quality of the pastures ... The *raiyats* are dependent on ... during the hot weather, ... deal of good fodder, ... are grown for Kang- ... garden land in February, irrigated and cut before earing

236 The crops most largely used as fodder-crops are *judr* (*Sor-* ... Principal crops used as fodder crops

The main differences between growing a crop for fodder and ... Thick seeding of fodder-crops.

sometimes fed green, and sometimes stacked when dry.

Over the Punjab generally fodder-crops are grown for cattle, and *judr*, or *chari*, as it is there termed, is the usual one Judr bajra, ragi

In Behar, *judr* is largely cultivated as a fodder-crop When young it is believed to be poisonous, and is put round the borders of fields to keep the cattle from trespassing on to the crops

This crop is also grown in Gujarat (Bombay), at Poona, and

Bájra, in many instances, takes the place of *juár*, but is considered inferior to the latter as fodder

In Madras, *rági* mostly takes the place of *juár*, though the latter there known as *cholu* is also grown, as well as *bajra* (*chimbu*) The straw of *rági* is considered to be the most nutritious of all, and that of both *juar* and *bajra* to be superior to rice straw. *Ragi* is used both as green fodder and also in the dry state

Sugar cane

Sugar cane (*Saccharum officinarum*), as a fodder crop, is used principally by the European planters in Behar Like *chari* it is sown thickly. It is chopped up when green and is mixed with dry fodder, such as oat straw, etc This makes a very good mixture for cattle.

Maize

Maize (*Zea Mays*), called in the Punjab *makki*, is extensively used as fodder in the Punjab and also in Behar and elsewhere

Oats barley wheat

Oats, barley, and even wheat are grown for fodder, the two former principally by European planters or on Government Stud Farms Oats are either cut green and chopped up as fresh fodder, or are allowed to ripen and are used as straw food Oats and barley are taken by the indigo planters as change crops for indigo

In the Punjab wheat is by no means infrequently fed off in its early stages, this strengthens the subsequent crop and prevents it from being beaten down by wind and storms

Gram

Gram (*Cicer arietinum*) is grazed over in the Punjab when still young In the Balaghat district of the Central Provinces pulses are grown along the tops of the embankments of rice fields and are used for cattle

Turnips

Turnips are largely grown in parts of the Punjab as a fodder-crop This is the case in the Jhang, Gujranwala, Montgomery, and Multan districts

Rape

Rape is another crop similarly used in the Punjab

Lucerne

Luce [illegible] the most valuable fod [illegible] Not only can several [illegible] the year, but the plant will last three or four years before requiring to be ploughed up and re sown

Lucerne is always grown and extensively used at Government Stud and Cattle Farms such as Saharanpur, Hapur, and Hissar, as also at Poona and other Experimental Farms

Next, I would mention two crops which, though tried experimentally with considerable success have not yet come into general use The first is "Guinea grass" (*Panicum jumentorum*) and the second the variety of *Sorghum saccharatum* known as *Sorgho* I saw both these crops growing at several of the Experimental Farms, and at the Seebpore Farm, Calcutta There is a ready demand for *Sorgho* in Calcutta by men who keep milking cows It can be cut three times in the year

Guinea grass

Sorgho

Prickly pear

Prickly pear (*Opuntia vulgare*) has been successfully used as food for cattle, and as (unfortunately for agriculture) it is only

too abundant in Southern India, the utilisation of it in time of scarcity would be most desirable The thorns with which it is covered are an obstacle to its use, but this difficulty has been overcome by Mr A Sabapathi Mudhar, at Bellary On this gentleman's Estate I saw prickly pear being largely used as green food for bullocks Women were employed to remove the thorns from the shoots after they had been cut and brought in This they do, holding firmly the pieces of prickly pear with one hand by means of pincers roughly made out of scrap iron bent into the requisite shape, then grasping with the other hand a pair of tongs also made out of scrap iron and with saucer-like ends, they seize the thorns with the tongs and pluck them out The pieces are then handed to another woman who cuts them into slices on a knife fixed vertically [illegible] the woman's foot A [illegible] move the thorns from, [illegible] as 120 lbs. of prickly pear in a day.

Utilised by Mr Sabapathi Mudliar at Bellary

Mr Sabapathi Mudhar has had experience of the value of this fodder, for during the famine of 1877, quite 75 per cent of his cattle were kept alive by means of it, they having nothing more to eat than the prickly pear and 1 lb a head daily of rice straw

Its value in time of scarcity

Eight years ago, when Mr Sabapathi Mudhar became Chairman of the Municipality, he introduced this plan of feeding the municipal cattle, and now they are fed regularly on the prickly pear, and the cost is only Rs 4 to Rs 5 a month per pair of bullocks

Mr Sabapathi Mudhar is now trying to cultivate a thornless kind of prickly pear

237 I now give some instances showing the necessity there is for extension of the system of growing fodder crops.

Need for extended use of fodder-crop

Mr Moens, writing of Bareilly (N.-W. P), says, in an extract already quoted —

Bareilly

"There are two points on which our agriculturists need instruction — (1) growing green crops for cattle, (2) the proper management of their manure"

In Chota Nagpur fodder crops are insufficiently known, for of Lohardaga Mr Basu says —

Chota Nagpur

"Cattle are small owing to insufficiency of food . . . . There is too little straw in the country not enough to give more than 2 lbs per head to working cattle daily, and this is only rice straw . . There are no fodder-crops

And of Palamau he says —

"There is an insufficiency of stored fodder, but it is relieved by grazing in jungle wastes . A lot of cattle are bred in the south and west parts in the forests

Mr. Nicholson says of Coimbatore

Coimbatore

[illegible] *mbu* is sometimes grown as a fodder [illegible] n dry land The *raiyat* prefers to [illegible] he grain and so double the yield.

Bájra, in many instances, takes the place of *judr*, but is considered inferior to the latter as fodder.

In Madras, *rági* mostly takes the place of *judr*, though the ... well as *bájra* (*chumbu*) ... t nutritious of all, and ... o rice straw. *Rági* is ... y state

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Gram — Gram (*Cicer arietinum*) is grazed over in the Punjab when still young In the Balaghat district of the Central Provinces pulses are grown along the tops of the embankments of rice fields and are used for cattle.

Turnips — Turnips are largely grown in parts of the Punjab as a fodder-crop This is the case in the Jhang, Gujranwala, Montgomery, and Multan districts

Rape — Rape is another crop similarly used in the Punjab.

Lucerne — Lucerne, where irrigation is available, is one of the most valuable fodder-crops, especially as green stuff for horses Not only can several cuttings (often five or six) be taken during the year, but the plant will last three or four years before requiring to be ploughed up and re sown.

Lucerne is always grown and extensively used at Government Stud and Cattle Farms such as Saharanpur, Hapur, and Hissar, as also at Poona and other Experimental Farms

Next, I would mention two crops which, though tried experimentally with considerable success have not yet come into general use The first is "Guinea grass" (*Panicum jumentorum*), and the second the variety of *Sorghum saccharatum* known as *Sorgho* I saw both these crops growing at several of the Experimental Farms, and at the Seebpore Farm, Calcutta There is a ready demand for *Sorgho* in Calcutta by men who keep milking cows It can be cut three times in the year

Guinea grass — Sorgho

Prickly pear — Prickly pear (*Opuntia vulgare*) has been successfully used as food for cattle, and as (unfortunately for agriculture) it is only

Use in preventing cattle-trespass

Again, they are very useful in preventing cattle-trespass and destruction of crops. Hedges are found over the greater part of Coimbatore, and Mr. Nicholson, writing of this, says :—

"Cattle-trespass is rare, cattle and crops are protected, boundaries respected, large quantities of fuel supplied, and protection is given to growing trees."

Mr. W. R. Robertson (late of Madras) mentions, in a Report on Bellary, that hedges of thorn would do much good there by affording similar protection.

In Anantapur (Madras) fencing is unknown.

Their occurrence

It is in the Madras Presidency that hedges and enclosing of fields are mostly found. I met with them generally in the Avenashi, Erode, Madura, and Salem districts, also at Hospet But they oc [illegible] ice, I saw them at N [illegible] Ahmedabad, Jeypore, U [illegible] The special way in which, at Nadiad, the hedges and grass borders to the fields are utilised has been mentioned in the last chapter (*see* paragraph 211).

Materials used for fencing fields

241. As materials for enclosing fields, mud walls are used in the Ulwar State, prickly pear at Jeypore and many parts of Madras, cactus hedges at Hoshiarpur, *euphorbia* hedges around Ahmedabad, as well as generally in Madras, and aloe bushes in Mysore. One of the most useful hedging materials is the *mullu-kiluvei* (*Balsamodendron Berryi*), a thorn which is largely used in Coimbatore and parts of Salem and Madura. It is easily propagated by cuttings.

Mr. Nicholson, speaking of the advantage of hedging fields, gives the following proverb —

"Note the field that is hedged, and the cattle that are pastured" Or, to put it in another form "Compare the cattle that are penned and the cattle "that are (merely) grazed,"

[illegible]

injurious to cattle.

Hedge material as fodder.

242. Lastly, there is a certain amount of value to be derived from hedges themselves as food for cattle Mr. Nicholson points this out in extracts already given in this chapter, and there is little doubt that in time of scarcity hedge material would supply, as was found in the case of prickly pear at Bellary, a useful store of fodder.

CONCLUSIONS

CONCLUSIONS

243 In so far as differences in agricultural practice are the outcome of attention being paid, in the better districts, to the growing of fodder-crops for cattle, and of enclosing fields with hedges, while in other parts these are neglected, it will be possible to effect improvement in agriculture by modifying these differences

It may not be possible to grow hedges everywhere, but the system is one undoubtedly capable of much extension, so also is that of growing fodder-crops, both being followed with much benefit We have here to deal with the third class of differences alluded to in Chapter II, *viz*, those arising, not from purely external sources, but *directly from a want of knowledge* The remedy must be sought, not in any direct measures which Government can introduce, but in the gradual adoption of the better practice by the people Government, however, and Agricultural Departments in particular, can aid greatly in the extension of agricultural knowledge, and in the transference of the practice of more advanced districts to those which are more backward

Fodder-crops, we have seen in this chapter, are necessary for the improvement of cattle, and in times of scarcity such materials as hedge-clippings, prickly pear, and trees, will be found immensely valuable

But little is known as to the comparative values of different Indian fodders, and there is a considerable amount of work in this direction which can only be done with the aid of an Agricultural Chemist

RECOMMENDATIONS.

RECOMMENDATIONS

244 I recommend —

The extension, wherever practicable, of the systems of growing Fodder-crops, and of Hedging or otherwise enclosing fields, more especially in parts where no pasturage exists, or where it is very scarce

The employment of an Agricultural Chemist for India, to investigate, among other matters, the comparative values of different Indian Fodders.

CHAPTER XI.

CHAPTER XI

LIVE STOCK AND DAIRYING

LIVE STOCK AND DAIRYING

245 THE subject which we now proceed to discuss is one on which there is not much to be learnt from the ordinary cultivator and his methods, and, in attempting improvement, the experience of Western practice will have to be drawn upon largely.

I have already spoken of cattle as affected by climate, by the existence of grazing, and the provision of fodder-crops Their importance as supplying the main source of manure to the land has also been fully dealt with

On points connected with the breeding of cattle I am not qualified to enter, and hence my remarks must be of a very general character

246 Inasmuch as both climate and [illegible] the breeding of cattle, more especially in [illegible] it is clear that, while improvement of [illegible] breeds is possible, it is nevertheless only so within certain limits

The Bengali will maintain that his cattle, though small, are strong for their size, and that bigger ones would mean more grain for them and more cost to keep In the Punjab, on the contrary, the bullocks are large and fine, they are well fed and carefully tended

247. Cattle represent the *raiyat's* capital, they provide the labour in ploughing and other field operations, they are used for drawing water from wells, and they supply manure for the crops In return for this, all that they get, in many parts, is the grass they can pick off the fields and roadsides during the rains, the stubble left after harvest, and the broken straw (*bhusa*) of cereal crops — The food of cattle

In other parts, as, for example, in the Punjab, they are well cared for, and are fed with special fodder-crops, with green grass, oil cakes, etc, or else they are driven out to pasturage and shelter during the hot months

The principal oil-seeds given to cattle as food were fully treated of in Chapter VII, paragraph 127 These are *til* seed, safflower, cotton seed, earth nut, and linseed In addition, gram and *dal* (*Cajanus indicus*) are often given

248 It must be allowed that there are excellent cattle to be found in the country for, in going through it as I did, or in visiting Agricultural Shows, one may see as good cattle as can be desired I was greatly struck with the appearance of many of the cattle exhibited at the Saharanpur and Meerut Shows and no one can fail to be impressed with the general excellence of — Excellent cattle may be found in India

the bullocks used for transit purposes, as also of those employed in military service

The trotting cattle and driving bullocks that one meets with in Mysore, Rájputana, and elsewhere, are singularly hardy and strong.

But, though individuals may be able to rear fine cattle and to keep up special breeds, this is something quite apart from the improvement of the cattle of the country generally, the cattle of the *raiyat*

Breeding and selection of cattle

249 The reason why better agricultural cattle are not more generally found is mainly because of the inattention paid to the matter of breeding and selection Further, the superstition that exists against the killing of bad cattle militates against the herds being better than they are Still, it is not everywhere that breeding and selection of cattle are neglected. In the Bombay Presidency the Gavlis, or milkmen, follow a system in breeding their cattle, it is mentioned in Reports of the Bombay Agricultural Department that in some villages of the Presidency the people are known to purchase stud bulls at their joint expense. In Gujarát a great deal of attention is given to cattle judicious crossing is studied, and calves are cared for, oil-seeds as well as fodder are given to the cattle A bullock will work here for 10 years at a well, or for 15 years if not put to well work

In the Southern Mahratta country, cattle are, as a rule, good. Nellore cattle are famous throughout the Madras Presidency, and in certain other parts The bulls are quite big at two years old, and cost Rs 150 to Rs 200 a pair Nellore cows are greatly prized also. Alambadi cattle are held in high esteem in the Salem district The bulls cost from Rs. 150 to Rs 250 a pair. The Administration Report of the Central Provinces for 1887-88 says —" In most districts " the bullocks used for agricultural purposes are of very good " quality "

The Panjab owes, in large measure, the existence of its fine cattle to the bulls sent from the Hissar Cattle Farm

From Palamau (Bengal) it is reported that the cattle have been improved by half-bred Behar bulls

Bhagalpur cows are in demand all over Bengal, the bullocks are used too, but are said to eat 2½ times as much as indigenous cattle The Amrit Mahal (Mysore) herd was broken up in 1885, but a certain number of breeding cattle are kept by the Mysore Government at Hosur. The Bhadgaon (Bombay) herd took its origin from this

Generally neglected

Though the above instances can be given, it is very generally the case that the breeding of cattle is left almost entirely to chance, and that no selection is exercised It has been pointed out in Chapter IX, paragraph 209, how largely the blame for this attaches to the "village waste," where herds of miserable cattle mix indiscriminately together.

In many parts of India the young bulls are the only sires of the young stock. They run among the herds until they are four years old, when they are castrated and turned into bullocks for plough or draught work In this way the young bulls often become sires before they are physically fit to get good stock After they are turned three years old they probably make fair sires, and the strongest animals do the most duty Still, it is a not uncommon sight to see an old bullock driving away a young bull from a cow, with the result that the latter may lose an entire season through not being served

250. The old Hindu system of breeding is carried on by means of the sacred bulls, or "Brahmani" bulls, as they are generally termed These bulls, dedicated to Siva or some other deity, are let loose when still young, on the occasion of funeral ceremonies, or in fulfilment of a vow. They are picked cattle, and, being sacred, are allowed to roam wherever they please, no one being permitted to kill them The custom is still maintained, and in some parts there are too many Brahmani bulls. Sometimes considerable dissension exists regarding the bulls, and frequent troubles between Hindus and Muhammadans arise on this account In many parts, however, the Brahmani bull is quite extinct, this being due chiefly to the decrease in free pasturage area, and to the decline of faith in the old religious beliefs The Brahmani bull

The Brahmani bull, where he exists, is almost always a fine creature, fed on the best of everything All that a cultivator may do is to drive the bull off his own field, though it may be only for it to go on to his neighbour's So well does the Brahmani bull fare that it is frequently asserted against him that he gets too fat and lazy to pursue his proper calling, and that the cows get served by the half starved bulls of their own herds instead Nevertheless, it is very certain that were it not for the Brahmani bull many villages would be very badly off.

In some parts, however, Behar for example, the bulls are too numerous, and cause serious damage to the crops of the indigo planters *Though they do not eat the indigo shrub itself, they* tread it down while searching for the grass that grows under its shade, but nowhere else Much expense has, accordingly, been incurred by the planters in putting ditches and hedges around their indigo fields

When the bulls get too many in number, Municipalities often seize them, and work them in the town carts. This proceeding so long as the bulls are not killed or sold, is quietly acquiesced in

In the North West Provinces considerable trouble has been caused by the depredations of cattle stealers and Muhammadan butchers Muhammadans, being meat eaters, have not the same sacred feeling towards the Brahmani bull as the Hindus have,

and the complaint of the latter is loud that numbers of these cattle are stolen for the purpose of being slaughtered, and that their flesh is sold.

Thus, I heard at Bharwari that the value of a bull had risen from Rs 10 to Rs 25 in consequence of the demand for its flesh Near Cawnpore I heard complaints that there were no Brahmani bulls left, and that the cultivators have to go to the nearest man who has a bull, of whatever kind it may happen to be. The agitation has, more recently, been increased by a decision given by Mr. Justice Straight, in which he declared the Brahmani bull to be "no one's property," inasmuch as it could not be said to belong to any particular owner. The bull is thereby deprived of the protection of ownership, and becomes more than ever the prey of the cattle-stealers and butchers, while the villagers are deprived of the means of getting their cows served. Surely, such a decision cannot be allowed to stand. That men should be allowed to steal and realise money by the sale of the flesh of stolen animals, and then escape punishment on the ground that the animals are "no one's property," seems manifestly unjust, and, in the interests of the agricultural communities, the practice should not be permitted to continue.

Legal decision as to ownership of Brahmani bull

Distribution of stud bulls to villages by Government.

251. It is very certain that without good bulls no improvement ... bulls ... they ... vern-

As I shall presently show, much benefit has been derived in the Punjab from the distribution of bulls from the Hissar Cattle Farm. ... rnment supplying other ... the Punjab. The pri- ... ve been abused A bull ... nder the charge of the ... similar official), and the ... ally to the local author- ... e Provincial Director of Agriculture to keep himself informed as to what is being done in each district to which bulls have been distributed. I do not think that any trouble need be taken about the food of the bulls If good bulls are given, the people will see that they are fed, and the responsibility on the village headman will suffice The system adopted at Hissar, by which the cultivators can go to the Farm and choose exactly what suits their requirements, is decidedly the best one, and should be encouraged

It is needless to say that the result to Government cannot be a directly paying one, but it is one which should be undertaken in the interests of the people as agricultural classes.

Selection of native cattle preferable to foreign sires

252 It is well, perhaps, that I should here interpose a remark to show that, when I speak of improving the cattle by using better sires, I am not at all in favour of trying to improve Indian cattle by crossing them with English bulls. The main

object in India is to produce cattle suited for *work*, and not, as in England, to produce either meat or milk. At the Bhadgaon Farm I saw a bullock that was a cross between a Mysore cow and a Shorthorn bull, a big, beefy animal, that ate a great deal, but was not adapted to ploughing.

Again, it is not enough, nor yet always the best way, to bring in fresh sires; attention must be paid also to the *selection*, for breeding purposes, of the best cattle of a district.

253. The distributio[illegible] involves the retention o[illegible] the location of bulls at [illegible] Cattle-breeding Farms necessary.

I am inclined to think that the good which has already been done by Government in this direction is apt to be overlooked I had the opportunity of inspecting both the Hissar Cattle Farm in [illegible] ombay [illegible] ak too [illegible] that I was much struck, not only with the excellence of the cattle at these Farms, but, what is more to the point, by the impress which they had left upon the cattle of the surrounding country through which I was then touring.

254 The Hissar Cattle Farm, at the time of my visit and for some years previously, had been under the able management of Captain Marrett. It covers 67 square miles in all, and has about 7,000 head of cattle on it, these being divided into herds according to the different breeds and ages It was started as long ago as 1813, the primary object being to supply cattle to the army for artillery purposes, a secondary one was to supply agricultural bulls for the Punjab and North-West Provinces. The artillery cattle are variously bred, according as they are required for "pole cattle" or for "leaders," or for other special purposes. The Gujarát cross and the Nagore cross are mostly used as "pole cattle," and the Mysore cross as "leaders." Hissar Cattle Farm.

About 350 head are supplied yearly to the Commissariat Department.

In addition, from 70 to 80 bulls are sold annually for agricultural purposes at the Government price of Rs 150 each Intending purchasers are allowed to go to the Farm and to choose the bulls for themselves.

On a farm of such extent there is almost unlimited grazing ground, but the grass is, seemingly, very poor and thin. It is only on spots where the water lodges that enough grass grows to afford a cutting. There is a further difficulty, that of procuring water, for the water-level is so low that wells, if made, would have to be over 100 feet deep. Captain Marrett's efforts to supply green fodder in the form of lucerne, *juár* (*Sorghum*), etc, are frustrated by the irregular supply of canal water, the Farm being situated at the very termination of the canal, and what water there is to spare goes first to the native proprietors (*zemindars*).

Notwithstanding these drawbacks, the Farm appeared to me to be capitally managed, and the stock bred on it were unquestionably fine. What struck me especially was the really splendid condition of the young stock. The calves were left alone in the yards during the day, but had their mothers with them at night; the latter were not stall-fed at all during the rains, but simply grazed throughout the day, and the fact that they were able to support themselves and their calves too, is a proof of how much the grass, unpromising as it looked, could do for them. All the cattle seemed to me excellent and in capital condition, and the spot must evidently be one well suited for breeding purposes.

Of the suitability of the Hissar cattle as transport and artillery bullocks I cannot speak, but I have no doubt of the *agricultural* good that is being done by the Farm.

Impress made in cattle of surrounding districts

Hissar was the first stopping-place in my Punjab tour, and as I went afterwards to other districts I made a point of particularly observing the cattle. I may briefly say that almost wherever I went in the Punjab I found that the existence of good cattle could be directly traced to the presence of an Hissar bull in the neighbourhood. Thus, at Ferozepore and at Gújrat (Punjab) the ordinary cattle were excellent, and in each case I came across fine Hissar bulls, roaming over the fields, just as the Brahmani bulls do. These bulls, I found on enquiry, had been given *gratis* by Government, but the boon had been appreciated by the people, for they are very fond of cattle. A pair of working bullocks at Ferozepore will cost from Rs 80 to Rs 100. In further support of what I noticed myself, I give the following extracts from the Punjab Administration Report for 1888-89 —

Karnal —"There were six Hissar bulls in the district at the end of the "year, in 1888 89 ten more were got and ten more were applied for as the "demand was keen and increasing. Practical farmers are deputed to Hissar "to select for themselves"

Hoshiarpur —"There are 24 Hissar bulls in the district which are effecting an improvement in the local breed. The *zemindars* highly appreciate "them, they are no expense, they are turned loose in the town"

Rawal Pindi —"There are 14 Hissar bulls in the district"

The following is from Major Massy's Report of the Kapurthala State for *1889 90* —

"Hissar bulls are regularly imported. Fifteen Hissar bulls were distributed "among the *tahsils*, and were highly appreciated. The young stock are "very promising"

Major Massy adds —

"It is notorious that animals of this class were never possessed before by "the Kapurthala peasantry"

I also find that in 1887 two Hissar bulls were sent as far as Arrah (Behar) for use on the Government Estates there

Bhadgaon Farm

255 On two different occasions I visited the Bhadgaon Farm of the Bombay Government. Cattle breeding has been established here for about 11 years, the herd having taken its origin from

the Amrit Mahal herd of the Mysore Government, since dispersed. The main object of this part of the Farm is to breed Mysore bulls for crossing with and improving the cattle of the country around. Here, as at Hissar, I ... were being reared which were v ... und in the country generally, ar ... e the latter if the right steps were taken to distribute the benefit. But it was not that the stock at the Farm alone were good, for, as I passed through the district, I saw evidence of the impress which the Mysore cattle reared at the Farm had made upon some of the other cattle, and how superior to the ordinary cattle were those which had the Mysore "touch" in them. The people of the district have now come to appreciate this, and there is an eager demand for any young bulls that are for sale. In 1889 nine young bulls, two to three years old, were sold at an average of Rs. 58 each. The young stock I saw at the Farm were also most promising. A short time after my visit, *viz.*, in October 1890, 27 young bulls, varying in age from six months to 18 months, were sold at an average of Rs 40 each for breeding purposes. By this sale alone, Rs. 1,080 were realised, whereas in the Farm Report issued previous to the sale these same animals had been valued at Rs. 650 only. I regard this as a strong proof that the people of the country will before long come to appreciate any source from which good cattle can be procured. The maintenance of the Farm as a breeding-farm for cattle is very desirable, and it is to this purpose that, I think, it is admirably suited, more so, indeed, than as an Experimental Farm in the stricter sense.

Influence on cattle of district

Satisfactory sales

256. I have said that the result of distributing stud bulls from these centres cannot be a directly paying one, in many cases, indeed, it may at first be necessary to provide the bulls free to villages. But the work of breeding good bulls, and of improving the cattle, must not be judged from the financial standpoint alone, but from that of the good effect produced in the country generally.

Results must not be judged from financial stand point alone

257. Where conditions are suitable, and where localities require it, I am distinctly in favo... made breeding-farms for the supply ... purposes Where conditions are ... where good sires are wanted, stud ... ernment Farms. This is done, for ... Madras. If stud bulls were located at the Cawnpore Farm it would, to some extent, remedy the deficiency already referred to in the matter of good bulls.

Government Farms should

Court of Wards' Estates, again, would be very suitable places at which to locate bulls. It is not, however, enough to merely ... on the part of ... in getting the ... When this is ... appreciate the

Also Court of Wards Estates.

them. The Gujarát, Sind, and Nellore cows are specially noted for their milking properties, qualities in which the Mysore breed, for instance, are deficient. The cattle of these special breeds are, however, very different to the ordinary country cattle.

Throughout Chota Nagpur the village cows are very poor, owing to insufficiency of food and want of fodder-crops, no oilcake or other additional food is given to them. From 1 lb. to 1½ lbs. of milk a day is all that they yield, and their value is from Rs. 7 to Rs 10 each.
each, and will yield about 5
to them in the dry season
2 lbs of milk is the average daily supply of a cow. In Dacca, cows are rather better cared for, and oilcake is given to them as well as to buffaloes. They will yield, in consequence, about 4 lbs of milk a day

In Gujarát (Bombay) milking-cattle are much more valued Thus, a cow will milk for seven months, giving 5 to 10 lbs. of milk a day, and will cost from Rs 20 to Rs 50 The buffalo is still more prized, and, being fed with oilcake, cotton seed, *juar* fodder, etc, will keep in milk for eight months, giving, for the first three months 20 lbs, the next three 12 lbs, and the last two 6 lbs of milk daily. Its value is from Rs 30 to Rs 100.

Nellore cows are good milkers. Some that I saw at the Saidapet (Madras) Farm gave about 20 lbs. of milk a day. They were being fed on 5 lbs per head daily of earth nut cake and bran, with *cholum* fodder.

Improvement of milking-cattle. 263 When such differences exist as are instanced above, it is very clear that in many parts improvement in the milking-cattle is possible As regards buffaloes, the people seem to appreciate their value, and there is little, I think, that need be done further But there is a good deal that may be done towards improving cows, more particularly where the sale of milk or the manufacture of the native butter, called *ghi*, is carried on. This will be found to be chiefly the case where pasture and grazing areas abound, and
cattle of the villa
share of the milk
done to maintain the cow specially as a milking animal, but the buffalo takes its place, and the cow is looked on rather as the breeder of future plough cattle Thus, while the distribution of stud bulls for breeding working-cattle is capable of wide extension, it will, I think, only be in special parts, and where pasturage exists in abundance, that improvement of the milking strains of the country cattle will be effected to any great extent

This matter has, however, not been altogether neglected at

being specially deficient in these At the Bhadgaon Farm, Malvi cows are kept as nurse cows for the young Mysore stock, and at Poona, investigations have for some time been carried on

as to the milk producing qualities of Gujarát and Aden cows, and on the influence of different foods upon the yield of milk.

Dairy Farming in India

264. Of late, efforts have been made to extend the practice of Dairy Farming in India. Mr Ozanne, who, at the time of my visit, was Director of the Department of Land Records and Agriculture in the Bombay Presidency, was foremost in the endeavours to foster this industry. A considerable impetus was given to the movement by the visit to India, in 1889, of Mr H. A Howman, a well known dairy farmer, from Warwickshire, England, and who came out on behalf of the Dairy Supply Company, Limited, of London, for the purpose of introducing the mechanical "Cream separators," for which that company were agents. These separators were of Swedish make, the invention of Dr de Laval, and were of a size which could be worked by hand-power. Mr Howman also took over with him a number of other appliances for making butter. The native way of making butter is, to boil the milk as soon as drawn from the cow, then to cool it, and, after adding a little sour milk, to let it stand from 12 to 20 hours in a brass vessel narrowed towards the top. After standing, the milk is churned by the rapid twisting round in it of a stick which is kept spinning round by the hand, first warm and then cold water being added now and again, but quite empirically. The butter "comes" in about a quarter of an hour and is strained off on to a cloth, the sour butter milk, called *ták* or *chas*, being much relished by the people. The butter is collected, put into another brass vessel, and melted over a fire. This operation requires careful watching, and good *ghi* makers are adepts at it. In the heating, the water is evaporated, and a portion of the mass, which is probably the enclosed curd, deposits at the bottom of the vessel, the remainder being poured into jars and stored. This is the *ghi*, or native butter, so largely used in cooking, etc., and it has the property, which ordinary butter has not, of keeping good for a long time.

Mr H A Howman's visit in 1889

Native method of making ghi

Mr Howman's experience

Mr Howman, when he first came to India, was met with what proved to be a difficulty,—the exceptional richness of buffalo milk. But this was soon overcome, and wherever the mechanical separators were shown at work, the opinion was universal that capital butter was produced, and that the system which Mr Howman demonstrated, that of making butter without it being at any stage touched by the hand, was an immense improvement on, and a far more cleanly method than, the native one. The butter which Mr Howman made would also keep quite well for a week. He further showed that he could not only make *ghi* from the butter produced, but that from the separated milk the sweetmeats and curds, in which the Native delights, could be made perfectly well. The separation also gave, in the form of freshly separated milk, a perfectly sweet and wholesome article of drink. In England the main difficulty [illegible]
the skim-milk, [illegible]
the Natives sho[illegible]
manufacture into sweetmeats, this obstacle may be overcome,

but not otherwise. It was, however, when Mr. Howman put himself into competition with the skilled *ghi* makers that he failed in showing that he could produce more *ghi* than the native manipulator He could always get more butter, but in making it into *ghi* the Native excelled I cannot, however, regard the trials as by any means satisfactory or complete In one butter-making trial which I witnessed, the native operator showed himself very clever in making up his butter with a great deal of water, so that it might weigh heavy, whereas Mr. Howman's butter contained no superfluous amount Then, when Mr. Howman's butter was made into *ghi* this was done by the *ghi* makers, and it is very certain that in some cases, at least, it was spoilt by them But the chief consideration is the following In the absence of any chemical investigation into the nature and composition of *ghi*, it is impossible to say what *ghi* exactly is, and whether, as made by the Native, it is purely butter-fat, or whether it does not contain some amount of curd The latter, indeed, is probably the case. The butter, as made by Mr Howman, was merely butter-fat, without curd; this may account for the fact that Mr. Howman obtained more butter but less *ghi* What is really wanted is the investigation of such points as these by an agricultural chemist resident in India itself.

Need of an agricultural chemist.

Mr. Howman's visit undoubtedly showed that great improvement was possible in dairy matters in India, but whether the benefit will extend beyond the European community is questionable

Steps taken to follow up Mr Howman's teaching

265 Mr Ozanne was not slow to follow up the stimulus given to the plans he had had for some time in contemplation.

Mr. Keventer, a Swiss, who had assisted Mr. Howman, was retained in India by the Bombay Government, and the Agricultural Department started a Working Dairy in the city of Bombay This was fitted with cream-separators, churns, refrigerators, etc, and so successful was the sale of butter, that, after a time, the concern was taken over by a private capitalist and worked by him. Then another capitalist started a second similar business, and, at the time I left, both were succeeding well At Poona, also, butter is similarly made by the Agricultural Department, and is sold in the town Mr. Keventer was lent for a time to the North-West Government, and at Cawnpore and elsewhere he showed the process of butter-making He was also engaged in demonstrating that cheese might be manufactured in India The berries of *Puneria*, it may be mentioned, can be used in India for the purpose of curdling milk, they are obtained from Sind At the Saidapet Farm (Madras) a cream-separator is used There is a ready sale for cream, and more is sold as such than as made into butter The students of the college (Natives) do not care for butter, so I was informed

Is there likelihood that improved dairying methods will spread in India?

266. This leads me to the consideration whether butter-making by improved methods is likely to make much advance in India I must say I hardly think that it will, so far as the native population is concerned Butter will not replace *ghi*, for the reason that it will not keep anything like the time that

ghi does. The Native, again, makes *ghi* with the simple utensils he has at hand, he could not make butter in this way. But, [illegible] population, then, I think, [illegible] benefit and comfort [illegible] idering how, in such towns as Calcutta, Bombay, Madras, Poona, Allahabad, and others, the English residents put up with the so-called "butter" with which they are supplied.

267. But of greater importance than butter-making is the question of the milk supply, of the conditions under which it is generally carried on the less said the better The surroundings in almost all cases are most insanitary, the manure heaps are too often close beside the wells and drain into them; the vessels are washed in this water, and the cattle drink it or other equally bad [illegible] in England, how readily [illegible] of milk, the wonder is [illegible] more closely traced to impure water, or to insanitary surroundings affecting the milk supply. The supply of milk to military cantonments is one affecting vitally the health of our troops in India, and that this should go on, as at present, without any control, is highly prejudicial to their welfare There is little or no check upon either the state of the places where the milk is produced, nor upon the adulteration (often with impure water) which constantly goes on Bombay and Poona are exceptions to this statement, as careful supervision is exercised there

Unsatisfactory condition of the milk supply in India.

Wherever troops are stationed, the supply of milk should be carried out by regular contract, and the sheds where the cattle are kept and the milk is produced should be under constant inspection and control by sanitary officers

268 Schemes for the establishment of regular Dairy Farms in connection with the supply of milk to troops have been suggested by Colonel Marriott, of Allahabad, and others, and I regard the proposals very favourably. Where troops are regularly quartered such Farms might with advantages be established, and should have a herd of good milking cows, with two or three stud bulls In addition to the milk supplied, the cows would produce calves, which, if females, would be the future milking animals, and if males, would do for entering into Government service as transport and artillery bullocks.

Dairy Farms.

The attention of the Commissariat Department should be strongly directed to this important matter of a pure milk supply to troops

In addition to military cantonments, Jails are institutions which would benefit from a regular and supervised system of milk supply.

At Madura, what was formerly the Experimental Farm of the Agricultural Society is now kept up as a Dairy Farm.

Madura Farm.

There are about 15 cows here, most of them good country cows, and a few Aden cattle They are reckoned to give about 12 lbs of milk each daily, when in full milk, and are fed with earth nut cake and gingelly cake Milk is sold to the town, but not cream, butter, or *ghi* This part of the Farm pays very well, and would seem to show that a good milk supply would be appreciated in native towns as well as where Europeans are in considerable numbers. Mr Ozanne has in prospect the establishment of a large Dairy Farm for supplying Poona with milk, butter, etc

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Horses

269. Horses do not in India come under the term "agricultural live stock," but, inasmuch as the Horse-breeding Operations of the Government of India are included under the work of the Agricultural Department, a passing reference should be made

Horse-breeding Operations of Government of India.

The object of the Horse-breeding Operations is, primarily, to supply Remounts for the Cavalry Formerly there were army studs at Hapur and elsewhere, but these are now given up, and the Cavalry have been supplied with horses imported from Australia and New Zealand. The endeavour of the Horse-breeding Department has been to improve the horses of the country by mating the country-bred mares with pure-bred sires. The selected sires are either Norfolk Trotters or thoroughbreds, imported from England, besides a few Arabs

At the different Fairs and Shows, country mares are chosen by the officers of the Department, and are branded as being eligible to be served by a stallion belonging to the Department Their produce are intended to supply the remounts The stallions are quartered in different parts of the country.

I went over the Hapur Farm, near Meerut, and saw the stallions of the Horse-breeding Department, and also the breeding mares, and the young stock belonging to the Army Remount Department It is found necessary to buy the produce of Government sires at as early an age as one year, for, if left till older, the horses are found to be mostly injured permanently. Also at Bhadgaon, Lahore, Gûjrat (Punjab), Hoshiarpur, and Salem, I saw stallions of the Horse-breeding Department that were quartered there In addition to the horses, there were, both at Harpur and at the other depôts, donkey stallions kept for mule breeding purposes In the Punjab and North-West Provinces these were very popular, out in Bombay the idea has not taken at all

In the Rawal Pindi district (Punjab) alone, there are 25 horse stallions, and 47 donkey stallions, belonging to Government.

In the Central Provinces, Government stallions are located, but are not much used, trotting bullocks being generally used for transit purposes

It would be travelling beyond my sphere were I to pass any detailed criticism on the way in which the Horse-breeding Operations are conducted. I can, at most, mention my general impressions of what I saw, without wishing to attach much importance to them But, after seeing Norfolk Trotters in England, I cannot say that I was favourably struck with the representatives of the breed that had been sent out to India, they appeared to be too heavy, too large bodied for their legs, to have a lack of style and a coarseness of leg which did not bring back to my mind the specimens I had seen in England It is, I believe, questionable whether the Norfolk Trotter is the right kind of horse to cross with the country mares in order to produce a *cavalry* Remount, the appearance of the young stock would indicate their suitableness for dragging guns rather than for making riding horses

In the case of the thorough-breds, the acquiring of a good animal seems to have been sacrificed to the obtaining of a high-sounding pedigree Of a number of horses that I saw at Hapur, the majority were rather "weedy-looking," and several were lame But the money difficulty comes in here, and when, as is the case, the purchase price is restricted to 250 guineas, or 300 guineas at the outside, one can hardly expect to get a really good sire.

The Arab stallions were, as a rule, very good, occasionally a little light the best I saw was one named "Ajeel," then standing at Hoshiarpur.

Some of the donkey stallions were also good The general fault with them was, that they showed a shrinking of the hoof

Sheep and goats

270. Of other farm live stock I need say but little.

Attempts have been made by Colonel Coussmaker and others to improve the breeds of sheep, and to obtain a better wool, but nothing of a lasting or general nature has been accomplished.

At the Saidapet Farm a fresh cross-breed, called the "Saidapet breed" has been established. At the Hissar Farm Jeypore sheep have been crossed with the progeny of Leicester tups and Bikanir ewes It is stated that the sheep now give wool, rather than the hair which they produced before.

The country sheep (Bikanir) have also been crossed with Australian Southdowns, but the latter only lived six months. Their produce, however, seemed to show an improvement in wool, the price realised for it off the farm being Rs 25 per maund [illegible] Rs 17 [illegible]

[illegible] one

pro [illegible] not le[illegible]

ing [illegible] But

is probable, also, that much can be done by careful selection of [illegible] stock already in the country, rather than by importation of bre[illegible] from other lands

Cattle Disease.

Cattle Disease

271. Comparatively little is known in India on the subject of cattle disease, and yet it is one of great agricultural importance, for, when an epidemic breaks out, the cattle perish in thousands, and do not seem to have a power of resisting it equal to that ... that cattle epi- ... they can only ... The variety of names by which diseases are known to the Natives in different parts makes it hard to ascertain how far they really recognise the particular ones and the respective symptoms To a certain extent it appears that the people are aware of the advantages of isolation, and make some use of it The herding together of a lot of miserable half-starved cattle on the "village waste" is, as I have previously remarked, one of the most potent means of spreading disease

In the Central Provinces, enquiries were lately made as to the means of checking the spread of disease, and the replies received indicated that the people would welcome Government interference to prevent the cattle of villages where disease existed, from mixing with those of other villages But the proposed isolation of individual cattle in a village hospital pound was not so readily approved, and it was felt that the owners would want to go and feed their cattle, and thus would themselves be the means of spreading infection Yet another difficulty is that of preventing the spread ... n cattle die the *Chamars* ... the animals, taking the ... It would seem that the only way of remedying the evil arising from this source is to give compensation for the hides destroyed ... much loss

Efforts made to cope with cattle epidemics

272. Within recent years efforts have been made to gain a knowledge of the diseases of cattle, and of their treatment

At Lahore (Punjab) a Veterinary College was established in 1882, and now has 90 students A dispensary and hospital are attached to it At Poona (Bombay) College there is a veterinary course, and men who have passed through it are qualified to take charge of the local dispensaries which have now been started at Ahmedabad, Nadiad, and other towns in the Bombay Presidency

Dispensaries

These dispensaries are used to some extent by the different municipalities for the treatment of their working cattle, and their wider usefulness is beginning to be appreciated In the Punjab also, there are similar dispensaries, and in the Central Provinces veterinary hospital assistants are sent out to different districts to treat the cattle in them.

Bacteriological Laboratory at Poona.

The most important step which has of late been taken is the appointment of Dr Lingard, a man of established scientific reputa-

tion, as Imperial Bacteriologist to the Government of India Dr. Lingard, after considerable European experience under men of such note as Drs Koch and Klein, was brought out to India in 1890, and located at Poona, a special laboratory being established for him there by the Government of India, for the express purpose of enabling him to pursue original research and investigate the causes and cure of cattle diseases in India This appointment is one of great importance, and is almost the first in which a man trained in scientific investigation has been brought to India and enabled to follow original research Associated with Dr Lingard is a selected veterinary surgeon, who undertakes the survey of cattle diseases in India, and in this capacity brings to Dr Lingard's notice any outbreaks or new diseases which manifest themselves in the country.

There is a probability that a bacteriological laboratory will also be started at Lahore, in connection with the Veterinary College there, and be used for the investigation of equine and bovine diseases

Retrograde action in Madras

273 In Madras, the step taken has, on the contrary, been of a retrograde character, as the Government have abolished the cattle disease branch of their Agricultural Department, and have given up, for the time, all attempts to cope with epidemics The outcome of a Government enquiry was to report that the veterinary staff was insufficient and inefficient, and that the cultivators offered opposition to the action of the veterinary officers

These do not appear to me valid reasons for giving up the attempt to learn more about the epidemics which annually clear off so many of the cattle of the country The first duty should be to provide a proper *training for the men who are to go about the*

draw up wise provisions for isolating cattle when affected, and for the treatment of disease, and then to insist firmly upon these being carried out Such work should manifestly be part of the duties of an Agricultural Department and not (as it has been made in Madras) that of the Education Department

I believe that the subject of cattle diseases in India opens a great field for investigation, and that wide-spreading benefits may accrue to the agricultural community thereby.

Cattle Disease.

Cattle Disease

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In the Central Provinces, enquiries were lately made as to the means of checking the spread of disease, and the replies received indicated that the people would welcome Government interference to prevent the cattle of villages where disease existed, from mixing with those of other villages But the proposed isolation of individual cattle in a village hospital pound was not so readily approved, and it was felt that the owners would want to go and feed their cattle, and thus would themselves be the means of spreading infection Yet another difficulty is that of preventing the spread of disease through the sale of hides When cattle die the *Chamars* or leather-dressers come at once and skin the animals, taking the hide for sale The hide is their perquisite It would seem that the only way of remedying the evil arising from this source is to give compensation for the hides destroyed

Mr Nicholson, in describing the state of Anantapur, says that *lakhs* of rupees are annually lost by cattle disease He points out that fencing is not done here, and that segregation would prevent much loss.

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Bacteriological Laboratory at Poona.

The most important step which has of late been taken is the appointment of Dr. Lingard, a man of established scientific reputa-

and other institutions is a most important one and demands urgent attention. The establishment of Dairy Farms is the best way to provide for the want of a pure milk supply Where dependence has to be put on native milk dealers the various establishments should be under control Up to the present there has been no scientific study of dairying matters in India, and an Agricultural Chemist should be appointed to carry this out

Encouragement should be given to the study of cattle disease, and to the employment of methods to prevent the isolating spread of epidemics The enforcement of regulations for affected animals will have to be firmly carried out, even if opposition be at first shown by the people

RECOMMENDATIONS

RECOMMENDATIONS

275 I recommend —

The continuance and extension of Cattle-breeding Farms and the distribution from them to villages, through Government agency, of stud bulls suitable for improving the agricultural cattle of the country.

The making Experimental Farms and Court of Wards' Estates centres for the location of stud bulls

The establishment of Dairy Farms for the supply of Milk to Troops and Government Institutions

The appointment of an AgriculturalChemist to investigate matters connected with Dairy Farming

The prosecution of Enquiry into Cattle Diseases, and into the means of preventing cattle epidemics

CHAPTER XII.

IMPLEMENTS.

Not much scope for improved implements under existing conditions.

276. P ... agriculture ... so-called " ... not unusual, among people who speak of the *raiyat's* farming as being "primitive" to say, "What can you expect when he uses a plough which merely *scratches* the soil?" After seeing for myself what is used, and what have been suggested for use, I am obliged to conclude that there is not much scope for improved implements under existing conditions. Not that the ones the *raiyat* uses at present are perfect, or that others have not advantages, but it is equally true that the existing implements have also advantages, and the suggested ones disadvantages, both of which have often been overlooked in the past That there is some room for improvement is shown by the success which has attended the introduction of the Beheea sugar-mill. Still, when this has been mentioned, I confess that one cannot go much further, and if the history of the Beheea mill is looked into, it will be found that it succeeded only after a close study had been made of native ways and requirements, and after the machine had been adapted to these. I have no hesitation in saying that if this method be not followed it will be quite useless to spend time and money in trying to effect improvements. Even if a thing be good in itself, patience, perseverance, and energy are required to make the Native comprehend its advantages, but when once he is thoroughly convinced of its utility he will not be slow to follow it up. It took several years of waiting before the Beheea sugar-mill began to make its way, but when once it was introduced into a district the demand for it often exceeded the supply, this has led in the past to many imitations and new adaptations of it, some bad, some good.

That improvement is possible is instanced by Beheea sugar-mill

Native requirements must be studied.

Ploughs

277. Ploughs have often been made the subject of attempted improvement, and yet the native wooden plough holds its own, and will continue to do so, I expect, whereas not one of the new kinds of ... tan" (Avery's) ploughs, both in use among the Behar indigo planters. A certain number ... cular districts named, ... the planters, they do n ... reasons are several, the first being that of *cost*. The *raiyat's* practice is to buy an iron share in the *bazar*, for 4 annas; this he

Objections to use of iron ploughs 1 Their cost.

takes, along with some *babul* wood, to the village carpenter, who then makes the plough In Eastern Bengal a wooden plough costs 8 annas only, but Rs 2 to Rs 4 may be considered the general range of prices throughout India The cheapest improved plough will, however, cost Rs 5 to Rs 6 The prices are as follows the "Duplex," Rs 5, the "Kaisar," Rs 6, the "Seebpore," Rs 6, the "Watts," Rs 7, the "Saidapet," Rs 8, and the "Hindoostan," Rs 12, As 8 Every attempt has been made to lessen the cost, but with ... standard, he ... advantage of ... Gujarat (Bombay) a complete set of farming implements can be purchased for Rs 20, and one may see, as I did, the oxen returning from the fields drawing along, in one load, some four or five implements, including plough, bullock-hoe, leveller, and seed drill

A second objection which the *raiyat* makes is the *weight* of an iron plough, it is, he says, heavy to work, his cattle are not strong ..., as he does his wooden ... These contentions are ... plough, generally speaking, weighs about 25 lbs, some are even lighter, the Konkan plough, for example, weighs only 20 lbs An "improved" plough will weigh from 30 lbs to 80 lbs But frequently, the native plough is considerably heavier than this The Khandesh plough, one in common use by the *raiyat* of that district, weighs no less than 150 lbs, it costs Rs 5, is worked by one pair of oxen, and goes down 7 inches into the black soil turning up heavy clods, which afterwards weather down The Nágal plough of Gujarat (Bombay), on the contrary, weighs 60 lbs (with yoke) and is drawn by from six to eight pairs of oxen Why there should be this difference, the smaller number of cattle being used for the heavier plough, is hard to explain, still, it is the practice, so Mr Ozanne assures me The heavy Deccan plough is worked with as many as 12 pairs of oxen At Shiyali (Madras) Mr S Sabanayagam Mudhar uses an "improved" plough, but his cattle are much superior to those of the surrounding country, and being better fed, they are able to work the plough, whereas the ordinary country cattle could not The value of the latter is Rs 10 a pair, and those of Mr Sabanayagam Mudhar, Rs 50 a pair The contention as to the greater weight of "improved" ploughs is, thus, not always correct, but yet taking the ploughs in more general use throughout India, and omitting those on heavy black and sticky soils, it may be said that the *raiyat* can, as a rule, carry them on his shoulder from field to field or to his home This is a decided consideration, for it may happen that a cultivator has land in two different places some little way apart, besides this, ploughs and other implements are never left out on the fields at night, for fear of their being stolen *2 Their weight*

A third and more potent objection is the *difficulty of repairing* iron ploughs When, occasionally, I have found iron ploughs used in a district, it has been where a proprietor owns a small foundry, and is able to execute the repairs there This was the case at Bellary Mr A Sabapathi Mudhar sells a number of *3. Difficulty of repair*

CHAPTER XII.

IMPLEMENTS.

Not much scope for improved implements under existing conditions.

276 PERHAPS in no direction have efforts at improving Indian agriculture been pushed more than in that of introducing new or so called "improved" implements Even at the present time it is not unusual, among people who speak of the *raiyat's* farming as being "primitive" to say, "What can you expect when he uses a plough which merely *scratches* the soil?" After seeing for myself what is used, and what have been suggested for use, I am obliged to conclude that there is not much scope for improved implements under existing conditions. Not that the ones the *raiyat* uses at present are perfect, or that others have not advantages, but it is equally true that the existing implements have also advantages, and the suggested ones disadvantages, both of which have often been overlooked in the past That there is some room for improvement is shown by the success which has attended the introduction

That improvement is possible is instanced by Beheea sugar mill

of th B hee . s gar m ll Still, when this has been mentioned,
uch further, and if the history of
it will be found that it succeeded
only after a close study had been made of native ways and requirements, and after the machine had been adapted to these. I have no hesitation in saying that if this method be not followed it will be quite useless to spend time and money in trying to effect improvements Even if a thing be good in itself, patience, perseverance, and energy are required to make the Native comprehend its advantages, but when once he is thoroughly convinced of its utility he will not be slow to follow it up It took several years of waiting before the Beheea sugar-mill began to make its way, but when once it was introduced into a district the demand for it often exceeded the supply, this has led in the past to many imitations and new adaptations of it, some bad, some good

Native requirements must be studied.

Ploughs

277 Ploughs have often been made the subject of attempted improvement, and yet the native wooden plough holds its own, and will continue to do so, I expect, whereas not one of the new kinds of iron ploughs have had more than a local fame Almost every Government Experimental Farm has its "pet" plough, the "Kaisar" the "Duplex" (Colonel Pitcher's) and the "Watts" plough, at Cawnpore, the " , at Madras,
the "Storr ' plough, at
Calcutta " Hindoos-
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reasons are several, the first being that of *cost* The *raiyat's* practice is to buy an iron share in the *bazar*, for 4 annas, this he

Iron ploughs in use of Government Farms etc

Objections to use of iron ploughs 1 Their cost

takes, along with some *babul* wood, to the village carpenter, who then makes the plough. In Eastern Bengal a wooden plough costs 8 annas only, but Rs. 2 to Rs. 4 may be considered the general range of prices throughout India. The cheapest improved plough will, however, cost Rs. 5 to Rs. 6 The prices are as follows the "Duplex," Rs. 5; the "Kaisar," Rs 6, the "Seebpore," Rs. 6, the "Watts," Rs 7; the "Saidapet," Rs. 8; and the "Hindoostan," Rs. 12, As. 8. Every attempt has been made to lessen the cost, but without avail [illegible]'s standard, he will be lotl [illegible] advantage of which has [illegible] In Gujarat (Bombay) a complete set of farming implements can be purchased for Rs. 20, and one may see, as I did, the oxen returning from the fields drawing along, in one load, some four or five implements, including plough, bullock-hoe, leveller, and seed-drill.

A second objection which the *raiyat* makes is the *weight* of an iron plough, it is, he says, heavy to work, his cattle are not strong [illegible] as he does his wooden [illegible] These contentions are [illegible] plough, generally speaking, weighs about [illegible] lbs.; some are even lighter, the Konkan plough, for example, weighs only 20 lbs. An "improved" plough will weigh from 30 lbs. to 80 lbs. But frequently, the native plough is considerably heavier than this The Khândesh plough, one in common use by the *raiyat* of that district, weighs no less than 150 lbs, it costs Rs 5, is worked by one pair of oxen, and goes down 7 inches into the black soil, turning up heavy clods, which afterwards weather down The Nagal plough of Gujarat (Bombay), on the contrary, weighs 60 lbs. (with yoke) and is drawn by from six to eight pairs of oxen. Why there should be this difference, the smaller number of cattle being used for the heavier plough, is hard to explain, still, it is the practice, so Mr. Ozanne assures me. The heavy Deccan plough is worked with as many as 12 pairs of oxen. At Shiyali (Madras) Mr S. Sabanayagam Mudliar uses an "improved" plough, but his cattle are much superior to those of the surrounding country, and being better fed, they are able to work the plough, whereas the ordinary country cattle could not. The value of the latter is Rs 10 a pair, and those of Mr. Sabanayagam Mudliar, Rs. 50 a pair. The contention as to the greater weight [illegible] but yet taking [illegible] and omitting [illegible] that the *raiya*[illegible] to field or to his home This is a decided consideration, for it may [illegible] different places some little [illegible] her implements are never [illegible] f their being stolen. 2 Their weight.

A third and more potent objection is the *difficulty of repairing* iron ploughs. When, occasionally, I have found iron ploughs used in a district, it has been where a proprietor owns a small foundry, and is able to execute the repairs there. This was the case at Bellary. Mr. A Sabapathi Mudliar sells a number of 3 Difficulty of repair

Swedish ploughs here Those used on the black soil go 1 foot deep, and require six to eight pairs of oxen, they cost Rs 50 each, but a smaller size used on red soil costs Rs 25 only One thousand ploughs in all have been sold, the repairs, however, are all done at Mr. Sabapathi's factory Mr Sabanayagam Mudliar, at Shiyali, also has his own workshop, where repairs can be executed Messrs Thomson and Mylne, who make the Beheea sugar mill, have found this same difficulty of repair, and have met it by establishing local depôts, taking back the worn out mills from the cultivators, and replacing them by new ones, in preference to trusting to local attempts at repair The manufacture of wooden ploughs, again, is a regular employment of the village carpenter, he forms part of the village community, and does not charge for his labour, but is kept up at the general expense of the villagers At harvest time he gets a proportion of the grain, and, in return, repairs and makes new ploughs all the year round His occupation would be in great measure gone were iron ploughs substituted for the wooden ones

4 The Native will not use an iron plough in the proper way

There is yet another objection The *raiyat*, if he be given a furrow turning plough, will not use it as it ought to be used, *viz* allowing it to run flat on the sole, but he will stick the point into the ground, just as he does with the native implement, and the work will be both faulty and difficult to manage It was at Nadiad that I saw a Native working with the "Saidapet" plough, the front wheel was quite up in the air, and never ran on the ground at all I saw the same done at Seebpore, with a plough introduced by Mr Sen, but, when the man was shown how to use it properly, the work was very good

[illegible] ably the first and third (cost [illegible] not think that iron ploughs [illegible]

Objections to deep ploughing in India.

278 Even if properly used, a plough that goes deep may do harm where a native one would not, *viz.*, by turning up inferior soil, and by bringing lumps of limestone (*kankar*) to the surface

Again, it is quite possible that, were deeper ploughing to be in vogue, the moisture, which, in the case of some soils, it is so necessary to retain, might be lost The turning over of a furrow [illegible], the [illegible] like [illegible] This would not occur with the native plough, the action of which is more like that of a pointed stick running through the ground, just below the surface, say 2½ to 3 inches deep, simply stirring and loosening it For hard and sun-baked ground, such as is often met with, no action could be better adapted, and, in a trial at Meerut I saw an English plough completely fail on such land

I have Mr W B Hudson's (Tirhoot) authority for saying that for breaking up land in wet weather the native plough is better than a furrow turning one, for the latter throws over a slice which will not break down readily

In black soil, too, a plough that goes deep is bad, if no rain falls after ploughing.

The fine tilth produced by the frequent ploughing with a native plough produces a surface which will absorb water better if rain follows, than would that left by a furrow-turning plough

Against deeper ploughing it may also be said that there is so little manure to go on the land, that more would be lost if the soil were turned up to a greater depth

Even when deep ploughing is employed, as by Mr Sabapathi Mudliar at Bellary, this is only done once in four years with the Swedish plough The native plough is used for the rest of the time

Further, land is frequently infested with weeds, such as *kunda* (*Saccharum ciliare*), which, if buried, will readily spring up, and whereas the native plough, with its digging action, tears the weed out and brings it to the surface, a furrow-turning plough would cover it over, and give to it the very bed it required for [illegible] with a field covered with [illegible] it of which will grow [illegible] a digging and stirring [illegible] ly good, working, as it [illegible] ater over it For break- [illegible] advantages, and some- [illegible] steam digger ''

279 At the Meerut (North West Provinces) Agricultural Show I was a witness of work done by native ploughs brought into competition with English and "improved" ones The field had oat stubble on it, and but few weeds. The English ploughs, drawn by horses, were altogether handicapped by the smallness of the plots, and by the difficulty of turning, so that they had no chance of even showing quick work But the long slice turned over (the ground being wet below the surface) soon began to dry in one mass, and looked very like forming into a hard brick under the influence of the hot sun, whereas the native plough just scraped the soil up, leaving it very fairly pulverised, and the stubble exposed on its surface. The best work, in the judges' opinion, and in my own also, was done by a "Watts" plough, for the soil was quite inverted, and yet it crumbled as it fell, covering over the stubble completely, and leaving the appearance of the field far more even than in the case of the other ploughs The covering in of the stubble, as I shall explain presently, may be an advantage or a disadvantage, according to the nature of the weeds and grass turned in with it But, after all, the judging of the merits of ploughs by mere inspection of the ground ploughed, partakes greatly of the nature of speculation Before the question of "improved" as against native ploughs can be settled for India, there must be actual demonstration of the superiority of the crops grown by one method as against those by the other

Trials of native and improved ploughs

I am well aware that deep ploughing has been advocated by Mr. Benson and others of great experience in India, and also that some

Swedish ploughs here Those used on the black soil go 1 foot deep, and require six to eight pairs of oxen, they cost Rs 50 each, but a smaller size used on red soil costs Rs 25 only One thousand ploughs in all, have been sold, the repairs, however, are all done at Mr Sabapathi's factory Mr Sabanayagam Mudliar, at Shiyali, also has his own workshop, where repairs can be executed Messrs Thomson and Mylne, who make the Beheea sugar mill, have found this same difficulty of repair, and have met it by establishing local depôts, taking back the worn out mills from the cultivators, and replacing them by new ones, in preference to trusting to local attempts at repair The manufacture of wooden ploughs, again, is a regular employment of the village carpenter,
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Until the foregoing objections, notably the first and third (cost and difficulty of repair), are met, I do not think that iron ploughs will be used to any considerable extent

Objections to deep ploughing in India.

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ing up new land the native plough has also advantages, and somewhat resembles the tearing action of the "steam-digger."

Trials of native and improved ploughs

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I am well aware that deep ploughing has been advocated by Mr. Benson and others of great experience in India, and also that some

experiments carried out on a small scale at the Cawnpore Farm seem to point to the advantage of deep as against shallow ploughing, but, although I am ready to allow, as I shall state later, that there are occasionally instances where deeper ploughing may be useful, I am obliged to conclude that it has not yet been proved that it would be of general advantage, and I could not therefore recommend it. Nor has it been shown that a mould-board is required on ploughs in India As to the Cawnpore experiments, I do not regard them as conslusive, and they are on much too minute a scale If the *raiyat* can be shown, not a small plot, but a whole field divided into two parts, one ploughed with the native plough, the other with an "improved" plough which he can purchase and also work with his own cattle, he may be led to believe in the superiority of the deeper ploughing when he sees a better crop produced on that half than on the other.

Numerous ploughings given by Native to his fields

280 It has been said that if the native cultivator had "improved" ploughs he could dispense with the many ploughings which he gives to the land, and that he would thus save himself the cost of going over his field again and again, crossing and re-crossing. These ploughings are always 3 or 4 in number for ordinary crops, and 8, 12, and even as many as 20, for sugar-cane and other special crops But the answer is, that the end is achieved in time, a finer and better tilth is obtained, and the moisture is not lost Besides, the *raiyat* has his bullocks, and it costs no more whether he works them or not, and his labour is not, as a rule, hired labour for which he has to pay, but is his own or his family's Ploughing, too, is generally done on a mutual accommodation system, neighbours working together on one another's fields, and in turn lending bullocks for the ploughing

It has been pointed out by Mr Benson and others how important it is to get sowing done early, and that a crop is often lost by the land not being sown in time But ploughing is an operation which goes on more or less the whole year round, and it is mainly where a broad stretch is put in with one and the same crop that there is the urgency spoken of, and this urgency is rather in the sowing than in the actual ploughing or breaking up of the land I cannot see that the greater area which an "improved" plough would prepare in a given time would compensate for the disadvantages which the *raiyat* would meet in the extra cost, difficulty of repair, and the need of stronger cattle, whilst, as regards the soil itself, I think it would in most cases be left in a better condition by the native plough

Had the *raiyat* to pay for the labour, I could understand that this item would counterbalance the cost of an "improved" plough, but this, as I have stated, is seldom the case

Where cultivators are, as a class, inferior, it is quite possible that they may delay sowing too long, but this is hardly the fault of the native plough, and it would not occur among the better cultivators, as, for example, those of the North-West Provinces.

281. There are cases, however, where "improved" or English ploughs may be profitably used. This will be, I think, only where there are large areas to be cultivated, time being thus a matter of importance, and the economy of quick labour and improvements having room to show itself, so that the question of first cost becomes relatively of no consequence. This, in my opinion, accounts for the adoption of the "Hindoostan" plough by the indigo planters of Behar over their wide fields, but the *raiyat*, though I hear that he likes the plough, cannot afford to go to the expense of adopting it on his small plot or holding. Cases where 'improved' ploughs may be used profitably

Both Mr Sabapathi Mudliar, at Bellary, and Mr Sabanayagam Mudliar, at Shiyali, are large landed proprietors, and I could understand the advantage to them of the "improved" ploughs. The latter gentleman had 287 tillage cattle, and he reckoned that he could do 13 acres with the "improved" plough in the time that the native wooden plough was doing 4 or, at most, 5 acres. So this meant to him an economy of cattle.

In Behar I have seen even the steam-plough do good service, and Mr W. B. Hudson told me that he considered it a good plan to plough with it about half an inch deeper each time, so as to bring a fresh layer of soil into use. Again, at Captain Chapman's estate at Bâti, Oudh, I saw a steam-plough at work. The "cultivator" was employed for the purpose of breaking up land and bringing it under cultivation. The land had previously formed the bottom of a lake, and such a matting of weeds and roots I have seldom seen. The steam-plough had as hard a task set as was possible to imagine, but it did its work splendidly; side by side was other land which had before been in the same state, but now, mainly as the
ficent crops. Had
Chapman brought
this land, it would be unreclaimed still, for I am sure that no implement other than the steam-plough could have possibly done the work. The steam plough

There are yet other cases in which I think an iron plough might do good. When land is clean and free from weeds such as *Kunda* (*Saccharum ciliare*), the turning over of a furrow would bury the stubble, so as to allow it to rot and serve as manure to the land. In Iron ploughs useful on clean land

field was left very even and clean. If there be nothing but stubble and harmless weeds, the turning in of these would enrich the soil by the added manure provided in the decomposing stubble and grass, instead of wasting it as the native plough would. If, however, the
ied,
be

In preparing land for sugar cane, a Native will plough 8, 12, or even 20 times, in order to get deep enough, and to render the Iron ploughs useful for sugar-cane.

soil fine enough Here I am sure that deep ploughing at the first would effect a great saving of labour The possible loss of moisture has not to be considered, for sugar-cane is almost universally watered artificially As a matter of fact, in the sugar-cultivation around Poona it is the practice to plough 7 inches deep with an 8-bullock plough.

Iron ploughs useful when rains very heavy

Lastly, it sometimes happens that, when heavy rains come on suddenly, the surface soil may get super saturated and water logged, the lower layer remaining firm and dry, whereas, had the soil been deeper ploughed it would have retained the water better and have allowed it to sink in to a greater depth, instead of soaking merely the surface soil, and then running off

Little scope for use of seed drills mowing and reaping machines threshing machines etc

282. If for ploughs of new designs there be but little room, still less is there for more expensive implements, such as seed-drills, mowers, reapers, threshing machines, etc. The native seed drill will strike every one who sees it at work as being wonderfully efficient, and leaving little to be desired At the Saidapet Fa [illegible] had been purchased at a cost of [illegible] already an efficient implement, [illegible] most improbable I can, however, understand that when one watches the slow process of reaping a crop, a number of men (and often women too) squatting down, cutting handfuls at a time, laying them in bundles, and then leisurely taking these home, he will naturally think that a mowing or reaping machine would pay better in the end But it is far otherwise, for there is no fear of rain falling and thus injuring the crop, and the *raiyat* gets all his work done in time, and very much more cheaply than if he used machinery Experience shows that, even in England, when labour falls below a certain level, it does not pay to use machinery, and reaping by hand may still under some conditions be more economical than by machinery So is it with threshing machines, the cultivator has his bullocks, they may as well work and tread out the grain, he has no fear of bad weather coming, and no urgent call on his time, nor hired labour to pay, besides, he gets the broken straw and chaff (*bhusa*) soft, so that his bullocks will eat it readily. At the Cawnpore Farm there is a threshing machine the price of which is Rs 188 but it is almost needless to say that none of this kind have as yet been sold

Threshing machines and winnowers

283 Threshing machines and winnowers, however, demand somewhat more attention, by reason of the importance attaching to the cleaning of grain, more especially that of wheat It is only on large estates, the "concerns" of indigo planters, and by Europeans generally, that threshing machines will have any actual use on the farm itself, and then it will be because in such cases there is a great deal to thresh, labour has to be hired, and saving of time is thus an object in view Against them it is urged that they break and chip the wheat a good deal, that they do not separate gram from wheat, and that the *bhusa* is not rendered short or soft, as it is by the process of treading out with bullocks

Their limited use

Inasmuch as the planter grows his oats, barley, or other grain

not for export, but for use on his estate the objection as to the appearance of the sample does not matter to him, and he finds, too, that his cattle, after a short time and on getting used to it, will perfectly well eat the straw thrashed by the machine However, to meet the objection (one, I think, based on custom and idea only), in some modern threshing machines an arrangement for softening the straw has been added Winnowing machines have met with more favour from the cultivator than have threshing machines, and he is ready, I think, to admit their usefulness If a small and not overexpensive machine could be supplied to the *raiyat*, as an inducement towards cleaning his grain better, he

is of no consequence, and some experiments conducted by Mr *Finucane tend to show that treading-out of corn by bullocks is* more economical than steam threshing It may be said generally, as regards machines, that, where speed is not required, cattle-power will always beat steam-power in India

Cattle power and steam power compared.

284 Anyone who has watched the clever devices of the native cultivators in the implements which they use for harrowing, levelling, drilling, raising water, etc, will see that if anything is to replace the existing implements it must be simple, cheap, and effective He will indeed be a clever man who introduces something really practical I was especially struck with the effectiveness of a small hand-pick, in common use for digging holes to put seedlings into Another useful implement is the *kodali* or hoe, I have heard indigo planters say that, if they could afford it, they would prefer to have their fields broken up with this hoe rather than with any kind of plough The Native raises the *kodali* above his head and brings it down with force into the soil It penetrates about 4 inches, and brings up the soil in large blocks which are left to weather down *Dub* grass (*Cynodon Dactylon*) can be exterminated in this way.

Native implements ingenious and effective

A short-handled hoe, called, in some parts, a *mamáti*, is in general use also, and is a most handy tool I was very pleased again, with a kind of wooden sledge which I saw at Igátpuri, and which is used for carrying rice seedlings from one place to another for transplanting As many as would make head-loads for 10 men are piled upon the sledge, and it is safely dragged by bullocks over fields and roads, however rough, and sometimes to considerable distances

In speaking of attempts made at improving native implements, I am reminded of a story which I heard about a man who tried to introduce spade digging into India Hearing that the Native did not wear shoes, he had a broad piece of iron fixed on to the spade, so that the foot might be put on it more easily, but he quite forgot that the Native never uses his legs or feet for driving anything into the ground with force, but does so entirely with his

Improvement must be on native lines

arms. It is useless to try to make the Native do anything of this kind except in his own way. Take, for example, the case of men mending a road and shovelling stones on to it, they do not work as English labourers would, but one man holds the handle of the shovel while another pulls at a rope fixed on the lower part of the handle just above the iron. In this way the stones are scraped up on to the shovel and deposited where wanted It is the same with ploughs; a Native if given a double handled plough, would naturally conclude that it was meant to be guided by *two* men, one at each handle

Improvement in Implements has been effected

285. Ingenious though native implements be, and hard though they be to improve upon, there are, nevertheless, instances to show that here and there it can be done These I proceed to consider

Implements sold at the Cawnpore Farm

286 At the Cawnpore Experimental Farm several kinds of implements are manufactured and sold yearly In 1888-89, 84 ploughs ("Watts" and "Kaisar"), 22 pumps, 24 corn-grinders (costing Rs. 25 each), and 8 chaff cutters, were sold at the Cawnpore Farm Sometimes implements are given out on trial, but most are sold outright

The Cawnpore pump

The pump sold here is generally known as the "Cawnpore pump." It is a kind of chain pump, and is admirably suited for raising water the depth of which below the surface does not exceed 20 feet The pump has had considerable success in the neighbourhood, though it hardly comes within the *raiyat's* means, the prices are, for 3 feet to 10 feet depth Rs 40, for 15 feet depth, Rs 45, and for 20 feet depth, Rs 50. This pump is an adaptation from one brought by Sir Edward Buck from Austialia After a long series of careful trials and modifications, made under the supervision of Mr. W J Wilson, of the Irrigation Department, North-West Provinces and Oudh, it was found that for depths between 15 feet and 20 feet the pump could beat all the native devices for raising water, but that at depths shallower than 15 feet or so, and again at depths exceeding 20 feet, the native appliances were superior

Sugar mills

287. The success that has attended the introduction of iron sugar mills has been touched on in passing (*see* paragraph 276) In many parts they have quite replaced the old clumsy native wooden mills The native mills are either the *kolhu*, a mortar and pestle arrangement, in which the cane is bruised and pressed, or else wooden roller-mills, of which there are two kinds, the *gundi* or *cherki*, consisting of two, or sometimes three, upright wooden rollers, and the *belna*, used in the Punjab, and made of two horizontal wooden rollers. The wooden mills cost Rs 20 to Rs 30, and last about 10 years. They are hard to work, and do the pressing very ineffectually, the canes having to be passed through the rollers several times, always three or four, and sometimes as many as eight times The only points in favour of the wooden roller-mills are, that they can be made locally, and that the canes have not to be chopped up or cut into short lengths, as is the case with the *kolhu* and with the iron mills, thus, the fibre, after pressing, is available for rope-making, and especially for ropes for wells For

the latter purpose the sugar cane fibre is much prized, as it will stand the constant immersion in water necessitated by the employment of the Persian wheel, the method of raising water most common throughout the Punjab. Still, it has been rightly pointed out that there are quantities of *munj* grass (*Saccharum ciliare*), which would serve the same purpose quite as well.

Circumstances affecting the out-turn of sugar

288. Anyone possessing a knowledge of the chemistry of fermentation is well aware how great may be the gain or how great the loss resulting from attention to or neglect of the numerous, and often seemingly minute, points which affect the condition of fermentable substances, such as the juice of the sugar-cane. Cleanliness, rapidity of expressing, speedy transference to evaporating-pans, rapid boiling, extent of surface exposed, removal of non crystallisable matters, proper desiccation, and final careful storage are considerations which favourably influence, in a most marked way, the out-turn from one and the same quantity of original material worked upon. There are a number of other determining factors, such as, the variety of cane grown, the method of cultivation, the manuring given, the influences of soil, weather, and watering, the time of cutting the canes, and the rapidity with which the canes are taken to be pressed. On all these matters knowledge in India is but limited, and a wide field is still open for enquiry. On one or two points there is some general knowledge, as for instance, that the quicker the juice be expressed, and the more cleanly the process be, the larger will be the actual yield of sugar. In these respects the Beheea sugar-mill and its imitators show great improvement over the native methods. The iron mill has also the advantage of being portable, and it can be worked by the labour which the *raiyat* can command. The Beheea mill was introduced in 1873–74, and, as first manufactured, was a two-roller one, costing from Rs 80 to Rs 100, but within the last seven years a three roller mill has been introduced, and is a greatly improved, though necessarily more expensive, machine. It crushes the cane before it is pressed, and thus presents it flat to the pressing rollers. I have spoken of the difficulty attending the repair of the iron mill, and how the proprietors, Messrs Thomson and Mylne, have met this by establishing depôts throughout the country, where worn-out mills can be replaced by new ones.

Need of scientific enquiry

Advantages of the iron sugar-mill over the native mills

The careful and prolonged study of what the Native really requires has, in this instance resulted in the production of a machine the advantages of which have been clearly grasped by him, hence the progress made.

Instances of extension of use of iron sugar-mill

289. I give the following instances of the extension of the use of the iron sugar-mill:—

1. Punjab

The Punjab Administration Report (1889) speaks of the Beheea sugar-mill and its modifications as being "the only implement successfully introduced into the Punjab in late years. In Rohtak it is 'driving the old "*kolhu* (native mill) out of use', in Kapurthala the substitution of it for wooden mills is actively encouraged. At first the cultivators would not take it, but when, in 1880, as the result of competition the price came down first 30 mills were purchased, and later on 200 more. There is abundance of *munj* grass (*Saccharum ciliare*) at Kapurthala to serve for well ropes. In

Hoshiarpur the iron mill is coming into use, the native mill (*belna*) is worked by three pairs of bullocks and the cane has to be passed through the rollers several times

2 Bengal

From Bengal there are many reports of the extension of the use of the iron mill, *e g*, in Lohardaga Palamau and Rungpore In Palamau the native *kolhu* has been driven out of use, and in Rungpore, on one Estate (Balashan) alone there are 300 iron mills in use

3. Madras

At Hospet in Madras I found that 75 Beheea mills had been sent there between January and August 1881 alone Mr Gond of Hospet has since pushed the sale of iron mills largely, and they are highly appreciated there
e wooden mills are all gone
r day Mr Gond told me that
as the people have not yet

4. Bombay

From Bombay it is reported that in one village alone, *viz* Velur, in Valva *taluk* Satara, there are 120 iron mills in use The mill is pushing its way in the Deccan but in Gujarát, with few exceptions, the wooden mill still holds sway

5 North West Provinces

It is in the North-West Provinces that most advance has been made, and iron mills are almost general The Beheea firm have depôts at Saharanpur and elsewhere

Respective merits of rival iron sugar mills

Work for Agricultural Departments

290 It is not for me, without special investigati n and trial to go into the respective merits of rival iron sugar mills, but I would say that these are legitimate points for Provincial Agricultural Departments to enquire into Experimental Farms are places where such trials should be exhaustively carried out

Shallow evaporating pan

291 Passing from the sugar-mill, I would next m depth,
implement the extended use of which would be atten dapta-
much benefit, I mean the shallow iron evaporating-pan f After
the expressed cane-juice in The more rapid evaporatio er the
by the broad shallow pan, as against that with the na ment,
deeper pan generally used, would give much less opportu epths
secondary fermentations setting up, and for impurities ative
their way into the juice Both of these circumstances w feet
a loss in the amount of crystallisable sugar yielded In ppli-
(Bengal) the shallow pan is in use, but not in Lohardaga,
in Dacca, in the latter earthen pans are employed In C ion
(Bombay) the use of the shallow pan is universal, but it 6)
known in Bassein, where deep narrow copper pans are in vog ve

Sugar turbine

292 Still more recently a centrifugal "drier" or sugar "tu tar
has been introduced into India, it effects the rapid separat ed,
the molasses from the crystals of sugar Though work ds
hand, and very efficient it is of necessity expensive, and can den
yet be expected to be applicable except where sugar is mac on-
tolerably large scale, or by a combination of *raiyats* A and
"turbine" of 36-inch size will deal with 50 maunds of crud ing
in 10 hours llers

Other implements

293. Ploughs, winnowing machines, and iron sugar mil as
about the only implements which the Natives have in any ls
appreciated, and, among these, the success of the last named o
been much the most marked le

Of other implements, I must say that it is not likely that they will enter to any extent into the *raiyat's* agricultural system

Chaff-cutters may, perhaps, be here and there appreciated, and a few have been sold at Cawnpore, so, too, may it be with corn-grinding machines. Others, such as bone-mills, water-pumps driven by wind, cream-separators and other dairy implements, mowing, reaping, and threshing machines, elevators, cotton-presses, etc., will only be employed on large Estates, on Grass Farms, or in connection with towns.

I can, however, indicate one implement of which there is need, this is a portable oil pressing mill At present the mortar and pestle arrangement adopted in the native wooden oil mill, though effective, is cumbrous Its cost is Rs. 50 In consequence, all the oil-seed has to be brought to a place where there happens to be a mill What is wanted is an oil-mill of a domestic size, which a woman can work inside the enclosure of her own house A way seems open for some one to replace the present oil-mill with some such machine as that with which Messrs Thomson and Mylne supplanted the wooden sugar-mill A portable oil-mill wanted.

294. But improvement in implements, or rather in the cultivation by their means, need not always proceed *from outside* existing Indian practice Sometimes it may be found that in a particular district an implement is unknown, or is inferior to one in use elsewhere, and improvement may be effected by the transference of practice At a little distance from Ferozepore, on Improvement by transference of use of native implements
the way to Ludhiana Mr E B Francis showed me some light
that th ;and on which when a shower of rain falls soon after sowing
the proc; is very apt to form, so that the young shoots cannot force
In thes way through it This is especially the case with barley and
great in less with wheat, when it forms, the people habitually re-sow
also the op, for they have no implement corresponding to a harrow
labour e instanced how careful the Behar indigo planter is to break
introdu is crust the instant it forms, using a bullock rake or harrow
roller o g spikes some 8 inches long and penetrating about 2 inches
seven the soil An implement of this kind if introduced at Feroze-
impro would entirely dispense with the necessity of re sowing The
the c rovement here would consist in a transference of native methods,
press

A similar instance is that of a
cultivation In the northern or
a drill, *is* used, but *not* in the
the grain is sown broadcast on

requ 295. Experimental Farms have in some cases been, and ought
mach e still more the places where different implements should be
him, to thorough tests Subsequently they might be the centres
28 distribution of such implements as had been found to be really
of the ficial, and which the *raiyat* would be able to avail himself of Trials of implements at Experimental Farms and distribution of implements by them

T it much more care must be exercised, I think, than has been given
mill the past before a machine goes out with the Farm's *imprimatur*
"tr it If it be found to be useless, or if it be beyond the *raiyat's*
" reach, it will not redound to the Farm's credit, nor to that of the
" Agricultural Department of the Province I have seen at Experimental Stations implements which there was not the remotest chance of the *raiyat* ever using, and, unless these are really requ--- Need of greater care than in the past

for the economical management of the Farm, their presence for demonstration purposes is a useless expense

Desirability of associating men of scientific attainments with agricultural enquiries

296 In conclusion I would remark on the desirability of employing in agricultural enquiries men of scientific attainments, such as engineers chemists, botanists, geologists, etc, whichever the circumstances of the case demand If this be not done, such experimental trials will lose the greater part of the value that might attach to them, and there will be no guarantee as to their being properly that is scientifically, conducted On the other hand real value may be derived from such experiments when carried out on a right system and with scientific help It is most desirable therefore that Agricultural Departments should employ in their enquiries the aid of skilled experts

CONCLUSIONS.

CONCLUSIONS

297. In considering the differences of agricultural practice which arise from the possession, in one district, of implements unknown in another district, we have passed entirely beyond the second main division of differences laid down in Chapter II. No longer do external surroundings enter, but it is altogether with the third division that we have to do, *viz.*, the differences which arise directly from want of knowledge

On this account the people can do little or nothing to effect improvement, while from the peculiar conditions of Indian agriculture, the Government cannot do much either

In brief, I do not think that there is any great scope for improvement in the *raiyat's* farming implements

Further, where any improvement is possible, it will come mainly from without and not from within, *i e*, by the application of Western science to native ways and requirements Very occasionally only will it be possible to extend the use of a native implement already in use in one part but unknown in another

The introduction of the Iron Sugar mill has, however, clearly shown that marked benefit may arise from the employment of machinery of Western origin provided this be carefully adapted to the needs of the Native Unless this provision be taken failure will certainly result

Similar benefit may result from the use of shallow evaporating-pans for sugar-boiling, and there is an opening for a portable oil-pressing mill

Although in some instances deep ploughing is advantageous, this is not generally the case in India, and I do not think that iron ploughs will take the place of the native wooden ones until the difficulties as to initial cost and repair can be met

For winnowing machines, chaff-cutters and corn grinders a limited future may be open, but other implements, such as mowers, reapers, threshing machines, elevators, bone-mills cream-separators, etc , a use will only be found on large Estates, Grass Farms, or in towns

The work of Government in connection with the introduction of new implements is to submit them to exhaustive trial at Experimental Farms and to work them side by side with the native methods.

If the advantage of a new implement is clearly demonstrated, then the Provincial Agricultural Department should make its Farm the centre from which to distribute the implement and its Shows the means of exhibiting the machine at work.

In conducting any exhaustive trials the Provincial Agricultural Departments should make use of experts in the particular branches of science connected with the enquiry.

RECOMMENDATIONS

RECOMMENDATIONS.

298. I recommend —

The exhaustive trial of new implements at Government Experimental Farms.

The association in trials of Implements of men specially skilled in the respective sciences concerned in the enquiry.

The distribution of approved Implements from Government Farms and the utilisation of Agricultural Shows for demonstrating the working of such Implements.

CHAPTER XIII.

CROPS AND CULTIVATION.

Scope of this chapter

299. A DESCRIPTION either of the crops of India or of their cultivation is not called for in my Report, and I shall therefore only deal with these matters in so far as any suggestion for their improvement can be made.

Possibility of improvement

300. I have remarked in earlier chapters upon the general excellence of the cultivation, the crops grown are numerous and varied, much more indeed than in England. That the cultivation should often be magnificent is not to be wondered at when it is remembered that many of the crops have been known to the [illegible] growing of maize, etc.

Changes pro- [illegible]

301. The increasing demands of other countries for wheat, [illegible] element of export has now entered into his calculations, and has marked changes in the kinds and extent of the crops grown.

Increase in wheat area.

Thus, in the Punjab, in the year 1888-89 alone, an increase of 11 per cent. was recorded in the area devoted to wheat-growing, no less, than 54 per cent of the *rabi* or winter-cropped portion or 31 per cent. of the whole cropped area of the year, being now taken up by this cereal.

In the Hoshiarpur district, sugar-cane is no longer considered the best-paying crop, but its place has been taken by wheat, sugar-cane coming next in importance, and then cotton.

Review of improvements cultivation discussed in preceding chapters.

302. In the preceding chapters much has been said in regard to improvements which can be effected in crops or in cultivation, [illegible] It has, for instance, been [illegible] aste prejudice would induce [illegible] systems of irrigation and of embanking land, together with improved working of the *taccavi* * rules, would enable larger crops to be grown; and that the better

* *See footnote page 80.*

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reason fail, the other will probably stand and cover the ground. This is a matter of no small moment, seeing that a *raiyat's* entire holding is only few acres in extent, and that it has to feed him, his family, and his cattle, and to pay the rent as well. In an experiment made at the Bhadgaon Farm it was found that a greater profit was obtained by intersowing cotton with *juár* or *arhar* than by growing the cotton alone.

"Mixed crops" are not confined to two in number on the ground at the same time, but several sorts may be sown together, for instance, wheat, barley, and gram (*Cicer arietinum*), or these with rape (*sirson*) as well. Wheat and gram often occur together, so also wheat and linseed, the latter frequently fringing the wheat field, and thus serving to keep cattle off, inasmuch as they will not touch the growing linseed. Cotton with *juár*, cotton with *arhar*, and wheat with mustard, are other instances of "mixed crops." There are many systems in ordinary use which are far more complicated than the above. For instance, not only may there be the rows of crops side by side, as noticed above, but the alternating rows may themselves be made up of mixtures of different crops, some of them quick-growing and reaped early, others of slower growth and requiring both sun and air, and thus being reaped after the former have been cleared off. Again, some are deep-rooted plants, others are surface feeders, some require the shelter of other plants, and some will thrive alone. The whole system appears to be one designed to cover the land, and thereby to prevent the bareness and consequent loss to the soil which would result from the sun beating down upon it, and from the loss of moisture which it would incur. It is known also that the process of nitrification in soils is much more active when a growing crop is on the ground than when the latter lies fallow.

305. In most parts it will be found that, whilst rotation is practised, no regular order in the crops forming a rotation is kept to, but that considerable latitude is exercised in their choice. Nevertheless, the crops will generally be found to follow certain rules of rotation, such as cereal after legume, and fruit-bearing crop after bulbs. The one crop with which rotation is not practised is rice. Why this should be so may be better understood when the conditions under which rice is grown are considered. Rice flourishes on silt-renewed lands that need little or no manure, and which are plentifully supplied with water. The water itself, by its constant renewal, probably makes the soil-constituents more readily available. Under these circumstances the rice plant becomes semi-aquatic in character, and is more independent of manure, and of the manurial benefit effected by rotation. Differences in the mode of cultivating rice may, however, be followed; thus, in some parts of Bengal it is the rule to sow rice broadcasted one year, and transplanted the next.

Rotation

Rotation not practised with rice

"seeds for your soil," runs the proverb, but the practice is different to the precept, and seed *is not habitually selected.*

Now and again selection of seed is practised to a certain extent Thus, in the Rawal Pindi Settlement Report, Mr F A R eitson points out that the Arains or Malliars are the best cultivators and that they select their maize seed The crop is, in consequence, far superior to that grown by the other cultivators He adds, "What is wanted is careful selection of seeds by the "cultivators, and the fostering care displayed by the Malliars "in bringing their crop to maturity"

At Hoshiarpur I found that, when *juár* was grown as a fodder crop fresh seed was obtained every year from another district, *viz* Ludhiana.

It is very certain that if more care were taken in the selection of potatoes for seed, and in change of seed, the crop might be greatly improved

The cause of the neglect

309. The root of the mischief lies in the system by which the cultivator is not his own seed merchant, but is entirely dependent on the *baniya*, *mahajan*, or similar individual of the money lending class These men supply the *raiyat* with seed, charging interest at an exorbitant rate, for they know that he *must* have seed or else he cannot grow his crop The accounts between merchant and cultivator, thus begun over seed transactions are seldom allowed to lapse, and often assume enormous proportions, leading to mortgaging of land and other evils It is in this that the utter improvidence of the *raiyat* is shown, and that he frequently becomes a prey to the money-lender Having saved no seed for himself for re-sowing, and having no money to purchase elsewhere, he has recourse to the means so ready at hand, and the land is practically charged with an extravagant burden, and one of the *raiyat's* own creation It is strange, indeed what a hold the money lenders have on the people, in one district of the Central Provinces I found well to-do cultivators who could easily have purchased their seed in the open market or from other cultivators, but who, nevertheless, went to the *mahajan* for it, because they liked to be on good terms with him, so they regularly borrowed from him, and paid him back at the end of every half-year.

Money lenders

Improvidence of the *raiyat*

Mr. Fuller, in one of his Reports, says, "Borrowing seed-grain is incompatible with improvement by seed selection," and this is *strictly* true But the practice has become almost universal, and the *mahajan* is a regular institution so that improvement cannot proceed to any great extent unless by an alteration in the *raiyat* himself

Cause of deterioration of cotton

In the case of cotton, the cultivator sells both fibre and seed, and the grain merchant, receiving many small lots of seed, often of different varieties, mixes them up together Later on, the grower buys back the mixed seed and sows it, and, thus, purity of seed and uniformity of quality are altogether lost.

310 As the *raiyat*, even under [illegible]
can hardly free himself from resorting [illegible]
merchant, because he has nowhere el[illegible]
it becomes one of the most useful acts which Government can [illegible]
do, to provide the cultivator with seed, or rather, with the facilities for obtaining it

The business of a seed merchant, as understood in Europe, is unknown in India and I do not think that there would be any scope for it even if it were desirable to introduce it But Government, by means of its Farms, might serve a most useful end in growing pure seed and in making it available for distribution to cultivators This has not been altogether neglected in the past, and the Cawnpore Farm of the North West Provinces especially, and also the Farms of the Bombay Government, have done good work in showing the advantage of selection and change of seed, and in the establishment of distributing centres for good seed But much more extended action is required before the cultivator can be rendered independent of the grain merchant The Farm at Cawnpore cannot now supply enough seed to satisfy the demands made upon it There ought to be not only Experimental Farms, but Seed-growing Farms, where the *raiyat* could buy pure and good seed at a moderate cost, instead of, as he does at present, going to the *bazar* and getting what he thinks looks best If the experiments at some of the Government Farms were curtailed, and more land were laid out in producing selected seed for distribution to the district around, I think more good might be done. This work does not imply the existence of a distinctly *experimental* farm, nor of a skilled staff, but there might well be under Provincial Agricultural Departments, a Seed Farm in each district to provide for the requirements of that district.

The Bombay Agricultural Department distributes seed in Sind to *zemindars* on the simple condition that the amount of seed given is subsequently returned to Government

At Nadiad the local Agricultural Association has established a seed store in the town, for the sale of selected seed at cost price The plan is slowly making way with the cultivators

Court of Wards' Estates, again, would be very suitable places at which to grow selected seed, and they might act as distributing centres for the supply of seed to the neighbourhood

Not only must the seed itself be available, but encouragement and facilities must be given to the purchase of good seed The system of *taccavi** advances is applicable to the case of seed purchase, equally as to the digging of wells and purchase of cattle But in the case of seed, advances are given only in time of scarcity, and not in ordinary times There would be no need of such restriction if Government became the grain supplier. As long as the cultivator resorts to the money-lending grain merchant, the working of *taccavi* advances

* *See* footnote, page 80.

conditions of the respective regions, that the transference is one likely to succeed The unsuccessful attempts to introduce English wheats into India are instances of want of understanding of the relative conditions of English and Indian agriculture, and provincial Departments of Agriculture would do well to consider these before they accept the assurances of enterprising seed merchants in England The season in India is too short for English wheat to mature, and, although grown in the cold season, the wheat does not (except in the hills) lie under snow, nor is it subject to severe frosts Consequently, 20 to 30 days of heat will cause it to grow rapidly, and if the grain be not formed by February the crop will be prematurely ripened What is wanted is not so much to try exotic or imported seed, which may be good one year and fail to produce good results the next, but to try indigenous varieties which have already been found by the experience of other districts to be well adapted.

When, however, a new variety has been found to be, beyond doubt, superior to a local one, Experimental Farms can do a most useful work in distributing the new seed, as also in selecting and perpetuating pure and good local varieties

Use of Experimental Farms in distributing new varieties.

312 It is not alone in the introduction of new varieties, but also in that of new crops, that improvement is possible Here, again, Experimental Farms have not been backward, and though it may be asked how many of the new crops tried at these Farms have ever been fairly introduced, I maintain that such work of enquiry is a legitimate one and that it is the necessary fate of all experimental work that only one or two things out of a hundred tried may possibly succeed, nevertheless, the record and observation of what has been done will not be altogether thrown away It will be known what has been tried, and so need not be tried again, also, what may possibly succeed under other circumstances.

Introduction of new crops

Introduction of new crops may take place in two directions The crops may be either entirely new ones to the country, or merely new ones to the particular district

The history of the present crops of India is one telling largely of importation, such imported crops are—the numerous millets (the principal food grains), maize, tobacco, tea (though the shrub was subsequently found and cultivated in India), coffee, the potato, and many other kinds of vegetables. There is, therefore, no reason why other crops should not be imported also At Government Stud Farms lucerne has been introduced with much success

Where a crop is not known to one district, but is to another, improvement may often be effected by the transference of practice There is little doubt that the cultivation of the potato might with advantage be introduced to fresh districts At Salem (Madras) vegetables, such as the onion, the pumpkin, the egg-plant, etc, are grown in profusion, but the potato is not raised, the people say they do not know how to cultivate

it. Wheat might be grown in parts of Eastern Bengal where it is not now known Oats might usefully find a wider sphere than they occupy at present

Exten on o c l a o t ex s g ops

313 An impetus can, in some cases be given to the extended cultivation of remunerative crops, such as sugar cane, potato, etc This will, however, result rather from the adoption of better modes of cultivation or of manufacture, than from oth r means At Dongasara in the Central Provinces, I found evidences in the dis used stone presses still lying about that sugar cane was formerly grown here but now it is not cultivated With the help of the new iron sugar mill the cultivation of sugar cane might once more be profitably followed
acreage under this cro
creased I believe that
variety of crops grown
much dependence on one crop alone Tanjore, for example, depends practically upon rice, Bellary upon cotton If other crops were more extensively cultivated the consequences attending the failure of the staple crop would be minimised

D seases f crop a l insec at acks

314 I wish to note here the desirability of gaining more knowledge as to the diseases to which crops are liable, and of the injurious insects which attack and destroy them It is satisfactory to note that the Government of India have, with the co operation of the Trustees of the Indian Museum Calcutta made a beginning in this direction and that the services of Mr E C Cotes of the Ento-
1, not only
estigating

The valuable services which, in England, Miss E A Ormerod has rendered to agriculture may be taken as illustrative of the good that may be done similarly in India

Out-turn of crops

C op expe me

315 There is still much to learn in respect of the out turn of d fferent crops A system of "crop experiments" or experimental cuttings is conducted in the Bombay Presidency and in a few other parts and has been found useful for settlement purposes The trials are conducted by D strict Officers, the crops over small accurately-measured areas being cut and the produce weighed The object is not only to get to know the yield of d fferent crops, but also to find out the incidence of assessment on the value of the gross produce and thereby to ascertain if the land tax has been justly estimated In a few cases further special experiments over entire holdings are made for the purpose of ascertaining whether a fair return is given for the cost of cutivation etc Considerable difficulty is experienced in getting these trials carried out accurately, and the returns need to be subjected to careful examination and criticism before being accepted I regard the work, however, as a very desirable one to carry on for by the compilation of these returns considerable agricultural knowledge may be gained as to the yield of crops in different parts of a Province, as well as of India generally, while, as stated they will also be found useful for assessment purposes

Transference of method

316. Improvement, both in crops and in their cultivation, may be effected by a transference of method from one country or locality to another. The introduction of new crops and of new varieties affords in itself instances of this improvement by transference of method.

Many of the improvements which I have summarised in paragraph 302 come under this same head, and are connected more or less nearly with cultivation I shall, therefore, only give now some improvements which are directly concerned with actual crop growing.

Improvement of rice cultivation
Sowing of rice

317. Rice, in its many varieties, is not sown in the same way everywhere Sometimes it is sown broadcast, sometimes it is transplanted from seed-beds It is known that the out-turn of transplanted rice is greater than that of broadcasted, and only the better varieties of rice are used in the former case Yet there are districts

pointed out to me that rice is sown broadcast in the Raipur and Bilaspur districts of the Central Provinces and is not transplanted even on the best lands. Enormous waste of seed is thereby incurred In the Sambalpur and Bhandara districts, on the contrary, rice is very extensively transplanted.

Manuring of rice lands.

The rice cultivation of Tinnevelly is far superior to that of Tanjore, and the out-turn is much better The difference is the result of the inferior cultivation in Tanjore. Whereas in Tinnevelly it is the rule to manure the land by ploughing in green crops, wild indigo, etc., this is not done in Tanjore The practice of manuring rice land is now becoming much more frequent. At Ahmedabad I found that it was the rule to manure with cow-dung, tank silt was also used. At Belgaum all rice fields are manured with cow-dung and with ashes from the villages

Ploughing of rice lands directly after harvest.

Again, in the better districts it is the practice to plough up the land directly after the rice crop is cut. This is done in Tinnevelly. Before being told of this, I had, when in Tanjore, been struck by the hard and baked surface of the rice fields after harvest, and I

in a finely-tilled state. But if the field were to be ploughed after harvest it would be easy to work, the stubble would be allowed to

well. At Shiyali (Tanjore) the cultivators allowed that after the

is enough moisture after the rice is off, a crop of gram and sometimes even of castor (*Ricinus communis*) is sown. At Belgaum almost all the rice land gives a second crop either of peas, lentils, or barley The seed is thrown on in the rough, and there is no great preparation of the land beforehand I find that Mr Nicholson, in speaking of Coimbatore, remarks on the advantage that would follow the ploughing of waste lands after harvest in November, thus enabling the November rains to be more utilised From the Reports of the Bengal Agricultural Department I take the following —

> Rice has been so long cultivated that there is little to teach the *raiyats*, "but those of one part can learn a great deal from those of another, *e g*, the "Burdwan *raiyat* always uses a rake Again ploughing of rice lands after "harvest to weather and sweeten the soil would be an advantage . . "in parts of Bengal *raiyats* spread hide salt to get rid of what they call a "disease but which is really the consequence of leaving the land unploughed"

Waste of seed sowing rice

Great waste of seed in sowing rice is undoubtedly often incurred. Mr. Nicholson found that in Coimbatore 80 to 100 lbs of seed rice per acre were used in the transplanting process, he estimated that on the 87 000 acres of rice land in the district no less than 3 100 tons of seed, costing Rs 1,40,000, were used

Mr. Sabaraiyagam Mudliar is also of opinion that far more rice is used in sowing than is necessary, and at Shiyali he adopts much thinner seeding than is usually practised around him. As instanced above, there is much waste of seed when, as in the Raipur and Bilaspur districts of the Central Provinces, rice is sown broadcast, instead of by transplantation

Excess of water used for rice cultivation in some parts

Inferior cultivation of rice is sometimes due to the fact that water is allowed to stagnate on the fields, this is the case at Dacca, and I have also seen it at Ferozepore There is little doubt that water is frequently shamefully wasted in rice cultivation, and though plentiful water is requisite, stagnation is harmful to a crop Mr Nicholson says—"The difference between a paddy (rice) "field and a swamp is that in the former water is not allowed to "stagnate on the surface" He instances that as much as 12 feet depth of water is sometimes used in a single season for rice cultivation It might be possible to effect improvement by a transference of practice in respect of the moderate use of water.

Rab cultivation of rice

I mentioned in paragraph 131, when speaking of *rab* cultivation, that in some parts of Bengal, where soil is poor and weeds predominate a kind of *rab* process is used, all manure being burnt before it is put on the land In other parts this process is not employed In Bombay the reasons for use or non-use of the *rab* process are well understood, but this is not the case in Bengal, and it is quite possible that a transference of method in this respect may be followed by benefit in parts where the system is not known

Early grazing of rice by cattle

An actual instance of the adoption of transference of method was mentioned to me by Sir Edward Buck. The Burmese rice-growers often complained of the crop getting too tall, and of the seed dropping out, but when some Behar cultivators came and settled in Burma they introduced the practice of letting their cattle graze

over the young rice, thus keeping it back This practice was thereafter followed by the Burmese cultivators with success.

Possibility of [im]provement of [c]ultivation [in so]me parts

[illegible] these [illegible]

Improvement in cultivation of sugar cane

[illegible] from another in [illegible] going round and round the field and forming a fine seed bed [illegible] inches deep. Next, the field is levelled and the cuttings of seed-cane are scattered broadcast over the surface. The seed is then lightly covered over with soil. In consequence, the cane grows irregularly, and a jungle is formed, weeding cannot be properly done, and air and light cannot properly penetrate.

Different systems of sowing sugar cane

The Mauritius system is to place the cuttings in holes about 9 [illegible] to 4 feet apart, or else to lay [illegible] in the bottom of which the [illegible]. The "hole" system is mostly [illegible] "furrow" system is the best [illegible] the "furrow" system is the [illegible] of sowing the seed-cane in furrows were to entirely replace that of simply levelling the ground [illegible] the field, a very much increased [illegible] Messrs. Thomson and Mylne [illegible] that this would be the case, and that the cane grows very much thicker if planted deeper Nevertheless, the Behar cultivator, even on Messrs. Thomson and Mylne's own Estate, continues, with few exceptions, to adopt his old plan of broadcast sowing, and non use of manure. It is noteworthy, however, that the iron sugar-mill is now universally employed.

Advantage of Mauritius system

[illegible] to make the practice universal.

Instances

As a contrast to careless methods of sowing, I call to mind a practical demonstration which a cultivator at Máhim gave me, of the way in which sugar cane is grown in the Thána district of Bombay. The entire process was carried out on a small scale before my eyes, and I could not but wonder at the great care displayed in every detail. The lines in which the cane was to be sown were pegged and marked out with strings, the seed cane was set at regular intervals a stick being used to mark the [illegible] water was [illegible] refuse) [illegible] (the latter [illegible] round the [illegible] little wonder [illegible]

Again, as contrasts, I mention the following from Mr. Basu's Report on the Agriculture of Palamau: "The cultivation of sugar cane is very "negligent, as now carried on, cuttings are sown at random and lightly "covered with soil; the fields are not hoed properly, and light and air do "not get in This is very different to that of the central districts of Bengal,

"where large kinds of cane, *e.g. samsera* are grown and are planted in 'furrows, the stems being wrapped up in leaves in the rainy season, thus "letting in light and air, here oil cake is used as manure and the fields are hoed So the Palamau *raiyat* gets his 25 maunds of unrefined sugar *(gur) per acre, while the raiyat of Burdwan or Hooghly will obtain* "60 maunds"

The Mauritius system of cultivating sugar-cane is practised around Calcutta, but is unknown in Bhagalpur and the greater part of the Patna Division The cultivation of sugar-cane is much better in Burdwan than in Shahabad, though the manufacture of *gur* is, on the other hand, superior in the latter At Hospet (Madras) sugar-cane is largely grown, it is always planted in furrows, these being split after about three months At Meerut, *Saharanpur, Hoshiarpur,* and generally *throughout* the North-West Provinces and the Punjab, the "furrow" system of planting is adopted by the better cultivators.

Improvement in cultivation of the potato

319 The cultivation of the Potato is carried on much better in some parts than in others I find it stated that in Rawal Pindi—

'Potato cultivation is not good and leaves much room for improvement, 'large and quick returns are obtained for a year or two and then fall off, owing to want of careful husbandry'

In Lohardaga, potato cultivation is not carefully carried on, but in Hooghly and East Burdwan it is good

Other instances of transference of method

320 The sowing of "dry" (unirrigated) land in Northern Madras by means of a seed-drill has been mentioned, whereas *this is unknown in Southern Madras (see paragraph 294)*

In Tinnevelly cotton is not drilled, but it is very probable that if this were done much less weeding would be requisite

Mr Hill, Officiating Inspector General of Forests, in his Report on the Coorg Forests points out the benefit that would result from teaching the Kurubars of Coorg the plan of teak seed planting adopted by the Karens of Burma At the commencement of the rains the seed is laid down in beds from which, as it begins to germinate, it is picked out and transferred to land on which rice, vegetables, etc, are grown The teak seed is put in lines 9 feet apart, and 4 feet intervene between each seedling The rice or other crop is reaped and the young teak plantation is left

I might mention many other instances where benefit would follow the transference of cultivation methods, but the foregoing will fully suffice to make my point clear.

CONCLUSIONS.

CONCLUSIONS

321. The differences which are met with in methods of cultivation throughout India are largely those belonging to the third class of differences set out in Chapter II, *viz*, those arising directly from *want of knowledge*. The variety of crops grown is, of course, bounded to a great extent by physical conditions, such as climate, soil, water, etc, but, as has been shown, it is in some degree also due to want of knowledge Improvement in Agriculture will, as before, result from a modification of these differences Such modification will be effected mainly by the transference of method from one district to another, and even from one country to another. The practice of other countries, as seen in the case of the many imported crops now common in India, as also in the planting of sugar-cane, may often be usefully adopted, so also may that of the better indigenous districts

In the work of transference of method the people are likely to do but little or nothing, and the duty once more falls upon Government, and upon Agricultural Departments in particular.

The principal improvements that can be effected are in demonstrating at Experimental Farms the benefits of selection and change of seed, in giving facilities for the supply, purchase, and distribution of good seed, in demonstrating the utility of new varieties of existing crops, in testing and introducing new crops, in investigating the diseases and attacks to which crops are subject; in transferring a better method of cultivation to a district where an inferior one prevails.

It is very clear that no work such as is contemplated in the foregoing suggestions, and more especially in the last-named, can possibly be carried out without a very thorough knowledge of existing practices This knowledge, it seems to me, is still wanting, and can only be attained by a definite system of Agricultural Enquiry.

RECOMMENDATIONS.

RECOMMENDATIONS.

322. I recommend —

The continuation of Experimental Enquiry at Government Farms in regard to selection and change of seed, growth of new varieties of crops and of crops altogether new, methods of cultivation, etc.

The Establishment of Seed Farms under Provincial Agricultural Departments for providing good seed for the various districts; and the giving of facilities and encouragement for the purchase of seed from these Farms by the cultivators.

The pursuit of the study of Diseases and injuries of crops.

The organisation of a system of Agricultural Enquiry, for the purpose of obtaining a thorough knowledge of present Agricultural methods, and for the transference of better methods to districts where inferior ones prevail.

CHAPTER XIV.

CHAPTER XIV

AGRICULTURAL INDUSTRIES AND EXPORTS

AGRICULTURAL INDUSTRIES AND EXPORTS

323 In addition to the ordinary crops which the *raiyat* cultivates for his own use there are some, such as tea, coffee, indigo, sugar, and tobacco, which undergo a process of manufacture before becoming marketable articles, and others, such as cotton and wheat, with which special considerations in the matter of export are bound up

In the previous chapter *cultivation* only was dealt with, and suggestions were made as to how it might be improved. I propose here to treat of points in which I think an improvement, either in *manufacture* or in the conditions of *export*, may be effected.

I said then that it was no part of my duty to describe crops or cultivation, so it is not for me here to describe manufacturing processes, or to touch upon the relations of trade between India and other countries, or upon the varying elements which affect it — Scope of this chapter

During my tour I had the opportunity of seeing the industries connected with the utilisation of the above named crops, and I shall briefly note any points which specially struck my attention as affording evidence of the possibility of improvement.

Sugar.

Sugar

324. Sugar-cane is certainly one of the most profitable crops for the *raiyat* to grow There is always a ready market for the manufactured sugar, and, generally speaking, the area of land under sugar-cane is not sufficient to meet the local demand for the unrefined sugar or *gur*, as it is termed. As a consequence of this, and of the high rates for transmission within the country itself, a great deal of sugar is imported from Mauritius.

In the Bombay Presidency it is estimated that, after deducting all expenses, a profit of from Rs. 30 to Rs 40 per acre may be made by sugar-cane cultivation The general out-turn of unrefined sugar (*gur*) may be put at one ton per acre.

Sugar-cane is a crop particularly well suited to India **The** soil is adapted to it, and the climate is by no means unfavou Where irrigation is obtainable, cane can, as a rule, grow yield a very rich return. India, indeed, in the mat production, ought to be an exporting rather country. It is well, therefore, to look at so have caused the present condition of this they can be removed.

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Sugar cane is a crop particularly well suited to India. The soil is adapted to it, and the climate is by no means unfavourable Where irrigation is obtainable, cane can, as a rule, grow well, and yield a very rich return. India indeed, in the matter of sugar production, ought to be an exporting rather than an importing country. It is well, therefore, to look at some of the reasons which have caused the present condition of things, and to consider whether they can be removed. Well suited to India

325. In the last chapter I have spoken of the cultivation of sugar-cane, and have shown that there is room for improvement in it. The improvement will consist principally Improvement in production of sugar

in adopting the "furrow" system of planting (*see* paragraph 318). Beyond this, there are points connected with the manufacture of sugar from the expressed juice, which have been touched on under the head of "Implements" (*see* paragraph 288). If I were asked what had tended most to render the manufacture of sugar not as satisfactory as it might be, I should be inclined to say, "The little that is really known as to what influences the yield of sugar." On these points I will briefly touch.

Improvement in sowing

326 In the first place, although it has been shown at Beheea that cane planted according to the Mauritius plan produces more sugar than when sown broadcast, more precise knowledge is required in regard to other parts of the country also, and the demonstration of the fact should be made clear to the people.

The yields from different varieties

Next, whereas many different varieties of cane are grown, very little indeed is known as to the yield of respective varieties In one district one kind of cane is in favour, in another a different kind. Sometimes a cane is required for eating purposes, sometimes one that will resist the attacks of white-ants, or one that jackals will not destroy But, though each may have its special merits, next to nothing is known of the actual amount of sugar that each will produce. Mr F M. Gill, of Nellikuppam (Madras), in a report issued not long since, points out the great differences which exist in the juice of different varieties of cane From his own experience he deduces the result that the variety of cane known in Trinidad as "Green Salangore" gives a better juice than any variety of cane grown in Barbadoes This variety Mr Gill believes to be the same as the ordinary Coimbatore cane He therefore advocates the cultivation of this variety in preference to any other. Mr. Gill strongly urges the necessity for investigation into this branch of the sugar industry, and that careful analyses and records should be made and collected.

Influence of weather soil water, and manure

327 The influences of weather, soil, water, and manure, in determining the yield of sugar, are but little understood. The reason is not far to seek It is, that no one has specially worked out the question for India. Here and there a few analyses have been made, and at one factory a chemist is regularly employed who [illegible] case or not still requires demonstration, at all events, it is given as one of the reasons why the sugar factory at Poona is not successful The period of ripening is, it is known, affected by the use of certain manures, but the particular way in which they act is not understood It has been noted already (*see* paragraph 99) that the native cultivator has a partiality for well water in preference to canal water, if both be obtainable, and that he sets a certain store upon water of a particular kind which is highly charged with

soluble salts and which he considers especially favourable to sugar-cane and tobacco crops The use of earth impregnated with nitre, for putting round the stems of sugar cane as a manure, has also been referred to (*see* paragraph 133)

T[illegible] of cutting can[illegible]

328 Next, there is uncertainty as to the right time for cutting the cane This can only be definitely arrived at by careful investigation and by the aid of chemical science It is well known, however, that the measure of success attained depends much upon the time of cutting If the cane be cut too early, the saccharine juice will be found not to be sufficiently developed, whereas, if left too long, some sugar will be transformed into fibre and other constituents The desideratum is to take the cutting at the time of maximum development of sugar The chemist at the Rosa Factory in the North West Provinces has made analyses showing that the top joints of the cane contain no cane sugar, even when nearly ripe, and that the common practice of reserving whole canes for "seed" is a wasteful one The West Indian planter only uses the top of the cane for "seed," and this, though done in parts, ought to be done universally in India

The ratoon system

329 Another point on which there is very uncertain information is the extent to which the system of "ratoon" growing is a profitable one In some parts, the cane, instead of being freshly planted each year, is allowed to stand over for a second, third, or even later season and is then called "ratoon" cane At Poona I saw such a crop of the sixth successive season, but the opinion is general in the district ' that ratoon growing " will pay for three years, but not longer The advantages are, that much less labour is required, and that only half the amount of manure is used On the other hand, there are the objections that after a time the land gets sticky, and cannot be worked properly, also that the new shoots spring out from "eyes" higher up the stem than they did when the cutting of seed cane was deposited below the ground, and in this way roots grow out above the surface of the soil, giving the cane a less firm holding and less power of drawing upon the nourishment placed below it I could not, however, obtain anything but expressions of general belief, and it will not be until the respective systems have been tried side by side, and the cultivation expenses, out-turn of sugar, and other items have been drawn up in a balance sheet, that really reliable information can be given Such work as this would be a most useful one for Agricultural Departments to undertake, and I would urge it being done, not only on Experimental Farms but on land in the actual [illegible] tal Farm, [illegible] t to those [illegible] of advantage to take land under ordinary cultivation, and to see exactly what it would cost the *raiyat* to carry out one or the other of two competing systems.

Experiments should be made upon its value

Transfer of cane to presses and rapidity of pressing

330 The point at which, perhaps, the greatest waste of sugar occurs is after the cane has been cut, and it is largely in consequence of imperfect management in the stages subsequent to the cutting that India is an importer of foreign sugar

Rapidity of transfer of the cut canes to the pressing machine, and rapid expression of the juice, are most essential, or the loss of crystallisable sugar through the setting up of fermentation will be very great. There are few things which are capable of more rapid transformation into less valuable products than is sugar-cane juice, and every effort should be made to limit the action of fermentation. If the canes, after cutting, be left about, or have to be carted long distances, or if the pressing process be long delayed, loss of sugar must supervene. It is in obviating such difficulties as these that the Beheea iron mill has done so much good. It can be easily transported to the spot where the crop is grown; it presses the cane rapidly, and does not necessitate the repeated passing of the canes through it as the old native wooden mill did, nor the cutting up of the cane into the short lengths required by the "mortar and pestle" mill (*kolhu*). Both these elements in the native method of procedure promote acidification and consequent loss of sugar. Dr. Waldie and others have shown that about 10 per cent. more crystallisable sugar is found in the unrefined sugar (*gur*) obtained by the Beheea mill than in the product made by the native mills.

Advantage of Beheea mill.

331. Not only must there be rapidity in pressing, but also in transferring the expressed juice to the evaporating pans, and in the boiling of the juice.

Evaporating pans and rapid boiling.

It is in this latter respect that a great improvement has of late been effected through the introduction of wide, shallow iron evaporating pans in place of the narrow, deep, copper or even earthen pans that were universal before. The exposure of a large surface promotes rapid evaporation and gives less time for changes to take place.

Another essential to success is the removal of scum and of non-crystallisable bodies from the juice as it is being evaporated.

332. Perfect cleanliness of all vessels used in the manufacture is requisite for obtaining the maximum yield of sugar. The presence of any foreign material, dirt, etc., will speedily set up fermentation; so, too, will the use of any vessel with an imperfectly cleaned surface. Messrs. Thomson and Mylne pointed out to me that they had effected considerable improvement by inducing the native cultivators around them to collect the expressed juice in tin vessels, such as are used for holding paraffin, instead of in their earthenware vessels or *gharrahs*. The tin vessels can be readily purified by burning sulphur in them and thus be kept sweet and clean, but the juice soaks into the porous earthenware pots and turns sour. Washing will not remove this and the vessel is never sweet; the consequence is that, when fresh juice is poured in, the acidifying process is quickly set up, and a certain amount of crystallisable sugar is thereby lost. Captain Montgomery, in the Hoshiarpur Settlement Report, says:—

Necessity of cleanliness.

"After pressing, a decided improvement might be effected in greater cleanliness; the vessels which hold the juice are not cleaned as often as they should be, and the juice therefore is very liable to acidification, while the general disregard of the ordinary rules of cleanliness in the sugar refineries is beyond description."

333. In Coimbatore and many other parts it is usual to throw lime into the juice as it is being evaporated, in order to neutralise any acidity, but this is done in a quite haphazard way. In other cases no process of purifying the sugar is used In Lohardaga and Palamau only the scum is removed, and there is no demand for sugar of superior quality. Refining process

The solid sugar called *gur* is the juice boiled down and allowed to cool into a mass. A liquid sugar called *ráb* is made by not ... by clarifying it ... cool in earthen ... it by a process of straining and crystallising-out which is conducted by the regular trader, though not by the cultivator. The process takes three to four months. The liquid sugar or *ráb* may also be purified at once by the "centrifugal drier," or "sugar-turbine," introduced by Messrs. Thomson and Mylne (*see* paragraph 292). The molasses drain away and leave the dry crystals As much as 50 maunds (of 80 lbs each) of *ráb* may be thus made into sugar in 10 hours. The centrifugal drier

A difficulty in the way of improving the refining of sugar is that the demand for sugar of any kind is so great that the inferior qualities fetch a high price, and the better quality will not command sufficiently more to make the refining remunerative A prejudice exists, too, against refined sugar, owing to the belief current among the Natives that it is purified by using the bones of animals. Native objection to refined sugar

334 The establishment of central Sugar Factories has been urged as a means of increasing the sugar yield of the country. It has been pointed out that while there are 2,500,000 acres under sugar-cane in India, the produce is only about one ton of sugar per acre, whereas in the West Indies it is about two tons per acre Sugar Factories

Improvements in cultivation are, as I ... but the Factory system, though it has bee... exceptions, been a failure. The reasons ar... in growing sugar-cane is, that enough manure cannot be obtained, and dependence has also very often to be put on canals which afford uncertain supplies of water. Then, the rainfall is more regularly distributed in Mauritius than in India, and the produce will be affected accordingly. Again, sugar-cane is cultivated in India on a number of small patches, often some distance from one another, and not on large areas as in Mauritius, consequently there is considerable loss in cutting and carrying the canes any distance to a Factory, and the portable iron mill is found to be the most convenient machine to use. The high price asked for the raw material is another and true obstacle to the success of Factories The local demand for *gur* is great, a good price is given for it, and there is an unwillingness to pay more for refined sugar. The working

season in India is only about 75 days; in Mauritius, Demerara, etc., it is from 100 to 140 days Lastly, only a few of the Factories are allowed to make rum from the molasses, and the prohibition, when exercised, destroys the profit of refining. The Factories at Poona and Baroda have failed from these reasons, but one in Kolhapur (a Native State) pays because liberty is given to make rum. The Rosa Factory in the North-West Provinces pays fairly, I understand, and it is worthy of notice that the Company employ a chemist of their own

Export and import of sugar

335 In 1889 90 nineteen million rupees' worth of sugar was imported into India, chiefly from Mauritius, whilst [illegible] rupees' worth of unrefine[illegible] Import is mainly confine[illegible] sugar has quite driven o[illegible] Provinces sugar, owing to the *cost* of transit within *India being* so *great* On the *other* hand, *export* takes place *on the* Calcutta *side* and from Madras. The question naturally suggests *itself—Why do* not *Madras* and *Bengal supply Bombay?*

Date sugar

Sugar is, in a few cases, derived from other sources than the sugar-cane, for instance, the Date-palm (*Phœnix dactylifera*) is sometimes used for sugar manufacture in the Lower Provinces of Bengal. Its use is, however, declining very much.

Extension of cultivation of sugar-cane

336. There is no doubt that a much larger area of land could be put under sugar-cane. *More manure* would be needed, and *perhaps more water facilities also. Still, it is noteworthy that,* around *Beheer, when* Messrs. Thomson and Mylne first *came to* it, there used to be only 1 per cent. of the cultivation under sugar-cane, and now *there is 10 per cent.*

Mr Nicholson points out that in Coimbatore there are *tens* of thousands of acres of wet land on which Rs 20 an acre are spent in order to grow a crop of *food* grain worth Rs. 40, whereas *on the* same land rich crops like sugar-cane and plantains, *worth Rs. 150 an acre, might grow splendidly.* Rich merchants, however, buy the land as an investment, and hand it over *to* poor tenants for cultivation, these latter cannot put a single rupee into the land, but are obliged to utilise it for growing grain crops to feed themselves Mr. Nicholson estimates the profit on the growing of sugar cane to be *from* Rs 75 *to* Rs 125 per acre, or, if made into sugar, from Rs. 85 *to* Rs 105 per acre.

Mr. Sen, in his Report on the Agriculture of Dacca, says:—

"The extent of land capable of growing sugar cane is probably *greater* "than in any part of Behar and *Lower Bengal,* and the supply of sugar- "cane for local consumption comes from places so far distant as Ghazipur "and Benares (both in the *North-West Provinces*) The soil *is fertile,* "but the cultivators are lazy and devoid of enterprise If properly "utilised, the land can produce sufficient sugar to supply the demands of "the whole of Bengal, but the cultivation of sugar-cane is at present "extremely limited.

Sugar cane used to be extensively cultivated in the Central Provinces. The juice was boiled *over wood* fires, and large areas

were denuded for the purpose of getting the firewood Now, owing to the scarcity of firewood, the cultivation of sugar cane has been largely given up Mr. Fuller, on coming here from the North-West Provinces, introduced the practice common in Meerut and Rohilkhund, and showed that the juice could be boiled quite well by using the *megass* or spent cane after it has passed through the rollers, and that firewood could thus be dispensed with

This is a good instance of improvement by transference of practice.

337. In the various points upon which I have touched I have, I think, made it abundantly clear that, in the cultivation and manufacture of sugar, there is sufficient work to call for the employment of a chemist for the purposes of that industry alone

Need for chemist

an industry of so much concern to Indian agriculture.

A considerable duty also rests on Agricultural Departments to collect precise information as to the cost of cultivation, the out-turn, and the merits of different implements and methods of manufacture, so that the most profitable one may be introduced and be generally practised.

Duty of Agricultural Departments.

Cotton.

Cotton

338. Cotton, like sugar-cane, is a very profitable crop for the *raiyat* to grow. The actual cultivation of it is thoroughly well understood, and I am not aware of any suggestion that can be made for improvement in this respect. There is, however, a great deal of information to be gathered in regard to the respective yields of different varieties, and towards ascertaining which is the most profitable one to cultivate

Cotton is generally a single year's crop, but perennial varieties are occasionally grown which are left for a second or a third year I saw perennial cotton growing at Ahmedabad and at Avenashi (Coimbatore). *The indigenous varieties now generally cultivated* give a short-stapled, hard cotton, although finer and longer-stapled varieties are still cultivated in some parts of Berar, in Broach and elsewhere. American varieties of cotton were introduced about 60 years ago, and have been acclimatised, principally at Dhárwar, they yield a fine and long fibre For the last 20 years there has been a steady deterioration in the quality of the cotton exported from India and the long-stapled varieties, which, under the special names, "Oomras," "Broach," "Dhárwars," etc., had acquired special favour in the Liverpool market, have been subject to an increasing and now enormous amount of adulteration with the inferior, shorter stapled kinds, so that the significance of the old names has now almost disappeared, and complaints as to the inferiority of

Acclimatisation of cotton

"Mixing" of cotton.

Indian cotton have been very great The cotton most largely used in this way is the *Vilayati* or *Varadi* cotton of Khándesh The [illegible] rinces, the Punjab, [illegible] wn as "Bengals," [illegible] as "Westerns"

Attempts to improve cotton

339 Many efforts have been made, and even Government legislation has been tried, in order to keep pure the finer qualities of cotton, and to prevent the increased growing of the coarser native kinds But all these efforts have failed, and at the present time the cultivation of the indigenous varieties is more extensive than ever The reasons are, briefly, that the country cotton is a better-yielding variety, it is earlier, and more hardy than the long-stapled kinds [illegible] price, the crop pays the *raiyat* well [illegible] mand for every bale that is grown. [illegible] seems to me, wisely), concludes that he is justified in continuing to cultivate the coarser kinds, and he does not care to run the risk of [illegible] in crop, besides having to [illegible] but little more return for [illegible] that he can the sooner repay the loan he has obtained for the seed and the cultivation The general opinion is that it is useless to interfere by legislation, and that unless it can be shown to the *raiyat* that he will get more for growing fine cotton than he does now, and more than will cover the risk he runs in the smaller and less certain crop, he will continue to grow the country cotton, and legislation will fail, as it has done before, to prevent him from getting and sowing the seed which he knows will succeed As long, too, as there is the ready demand which exists for the country cotton, and so long as merchants will not give higher prices for better kinds, the supply of country cotton will be maintained. But if the complaints made against Indian cotton proved to be so well founded that the merchants had to stop purchasing the cotton, then, I believe, the *raiyat* would very quickly alter his practice and grow the finer kinds. In this matter, as in many others, the cultivator would show himself quite alive to his own interests, and he may be very well trusted to do what pays him best

The preservation of better varieties

340 There may, however, be some fear that if there were a sudden demand for finer cotton the *raiyat* would not have the seed for growing the crop Therefore, I regard with favour a proposal made by Mr. Ozanne, to grow and to perpetuate a certain quantity of pure seed of some of the better varieties, such as *bani* and *jari*, which are still known in Berar

[illegible] some recog- [illegible] cotton grown. [illegible] lmittedly finer varieties, although merchants might be willing to pay a higher price for them.

The misfortune as regards the cultivator of the better kinds of cotton is, not only that there is no protection afforded to him whereby a certain name and better price would be secured for his

cotton, but that, through the system of obtaining seed cotton by advances on it from the grain merchant, a pure seed is not obtained for re sowing The cotton pickers are always paid *in kind*, receiving so much seed in return for their labour, they take the seed in small lots to the grain merchant, who mixes all the seed together, and the cultivator buys back, not his pure seed, but a *mixed* lot Thus the purity of a variety becomes lost

The Cotton Presses which are now distributed over the country are, it would appear, responsible for a part of the systematic "mixing" which goes on The cotton is brought in, cleaned, and packed by the Presses for transmission to Bombay and other ports for shipment A Cotton Press which I saw at Jeypore had paid all its expenses in the first three years of its existence. The "mixing" of cotton which goes on up country is due, in great measure, to the fact that the merchants at Bombay and other ports, instead of purchasing direct, leave the execution of their commissions to native local traders, in whose hands is, therefore, the entire manipulation of the cotton. If the merchants were to go up-country themselves and purchase direct from the producers, a better state of things would prevail

Cotton Presses

"Mixing" of cotton

It would be a mistake, however, to suppose that all the "mixing" of cotton goes on up country. On the contrary, the European merchant is greatly to blame, and very much of the "mixing" goes on at the ports of shipment, under the eye of the heads of European firms

341. The whole question of the adulteration of cotton is one the remedy for which seems to rest rather with the trade than with agriculture. If there were a demand for long-stapled cotton, and if the trade were willing to give more for it, the cultivator would soon grow it, but so long as the demand for cheap cotton is so
would be unwise to interfere
iy to oblige the *raiyat* to grow

The remedy rest wi h the trade

342 Dr. Watt estimates the total annual production of cotton
wt are consumed
principally to the

Export of cotton and cotton seed.

I have spoken of cotton seed as a food for cattle, and have mentioned that it is but little exported (*see* paragraph 127) Dr Watt

cotton seed available annually for export

Indigo.

Indigo

343 The cultivation of indigo is, perhaps more than that of

as yet, been specially directed to it, I have little doubt that it will be found to possess properties similar to those already established in the case of other *Leguminosæ* that have been studied. Presuming this to be the case, we may have in this the explanation of the continued cropping with indigo that is such a remarkable feature in India It is not, I should point out, a parallel case to that of con- is been clearly cultivation of West Indies and elsewhere In these cases the continuity is maintained by the

Comparison with continuous corn-cropping

Rothamsted, Messrs Lawes and Gilbert have grown wheat and barley continuously for 50 years without change, by the aid of artificial manures. At Woburn, I myself have under observation similar experiments where these corn crops have been sown year after year for 16 successive seasons, and still continue to yield an undiminished produce. The limit, so far as the practical farmer is concerned, is that of the expense and trouble of keeping the land clean, and of freeing it from the weeds which are the invariable concomitant of these crops. These can best be got rid of by introducing a change of crop, and by growing one the habits and cultivation of which differ from those of the crop which has preceded it. In this sense a root crop may be termed a "cleaning" crop.

Practical limits.

But though the case of indigo is analogous in the respect ccasional "cleaning," it is very different in treatment Broadly, it may be said that the digo is indigo itself, in the form of the refuse and leaves, termed *seet*, which are removed from fter steeping has been done. Artificial manures have way in India, and where they have been tried for indigo not clearly shown any compensating benefit. Even er manures, such as lime, gypsum, nitre, etc, there is as to their efficacy. *Seet*, on the other hand, is

Manuring for indigo.

moisture-holding pro- is, that he has not on and for put on the land as he would like. tion, accordingly, is not an illustration of nsed with by means of heavy manuring, n of its continuation may possibly be found h it shares with some others of the *Leguminosæ*, atmospheric nitrogen This opens up a very f investigation, for which India affords special

343. The cu ny other crop, tical than of a the objects of ter into the d indigo may thus be, and is, taken year after wn that a change of cropping is occasionally

Change of cropping.

desirable or even necessary. This is termed a "rest" for the land Similar, though more serious in result if not freely

worm (*Tylenchus devastatrix*), whose extermination is best effected by "starving it out," in other words, by growing in place of the clover some crop on which the *Tylenchus* will not thrive, and in not repeating clover until the pest has died out

Insect ravages

Similarly, the indigo crop has its own particular ... cipally indi- though their ravages are not so general as to prohi... ...e sugar-cane, tion of the crop Caterpillars and a kind of crick... ...ing cattle (*see* which burrows in the ground, are its principal ene...

Advantage of change of cropp ng

A change of cropping is the most effectual ... proved by the rid of the pests, both insect and vegetable, w... some extent plant, and which are more or less fostered by ...vious chapters of one and the same crop upon the land A ... ceised in tilling vation is also beneficial to the soil, and the g... ...ng any loss of different in its plant requirements to the prece... after rain has dormant or non utilised constituents in the sc... ...eed is carefully of to the advantage of the new crop I belie... or "improved" cropping might be usefully followed in indigo ... ...y employed in much greater extent than is now the case, a... ...ndigo estate expenditure of more manure What has told in ... ...so ... the practice is the anxiety of the planter to get ... the supply ... the asas possible out of the indigo cultivation, a... ...laints made which will as great a breadth of land in indigo as he can. ...ed that the ... ge sam

Selection and change of seed.

347. Care i... shown in the selection o... ... believe, the respect the Europe... planter does not follow ... ...ow the finer are English mercha... at Cawnpore and el... ...ivator would on the their business to sele... and sell good seed t... may be very ... s made planter in turn is ve... merely a when land ...ch as

Unsolved questions as to cultivation.

Thick or thin seeding

Manuring

348. There is, ... thick-seeding or thin-seeding is the ... a pro... The capa exists as to manuring, except in the ... qua... my opinion indigo plant or *seet* The *seet* water, or ... and ... been quite settling tanks in which the finely divided ... It has been is sometimes used on the land with a ... me ... the it is more often allowed to run to waste, as ... ...re atmospheric value has yet to be demonstrated, and I ... the leaves opinion on the point ... without chemical ex... upon the mental trial There ... much difference o... ...n trogen whether *seet* should b... ...d on the land ... planter has his own ... of what is best ... Another disputed questi... when the *seet* Some planters cart i... straight awa... vats, others prefer to le... ... to apply it ...

I have been on estates where it is the practice to collect bones, to grind them in a mill, and use them as manure; more often they are collected, broken and bagged for export Thus, even by the European planter, the value of bones has not been established, or, rather, a better return can be got by the sale of the bones I have been with a planter whose belief in the sulphate of lime (gypsum) and other sulphates was almost unbounded, also with another who thought that nitre was what was wanted for indigo, whilst many more whom I met ridiculed equally either idea But I never saw anywhere what I would call a "comparative trial," conducted on a level uniform piece of land, with portions marked off, one cultivated in one way ...other in a different way. Suppose, for example, one plot Rothamsted, , the adjoining one thinly; one manured with *seet* barley continuou the other with a thin dressing only, one on which artificial manure been poured, the other with the same volume of similar experimer only, one manured with fresh *seet*, the other with after year for anured with bo- undiminished pro one without. concerned, is that and I might clean, and of fr to show what scope there is for enquiry in concomitant of h the cultivation of the indigo crop. The most introducing a ch rom any planter was that he had tried this or and cultivation ear, but he could not see any benefit from it, has preceded it repeat the trial But I cannot regard these as "cleaning" crop. ials" An experiment, to be a real one, must

Neglect of experimental enquiry in indigo cultivation

But though e practice against another, carried on side by of requiring an imilar conditions as possible, and it may have that of manure, and ought to be repeated, before a definite only manure can le come to. It is not that a large area is indigo twigs that the risk of heavy outlay is incurred For an the vats afl area, an acre, or even half an acre of land would made no wa nd if every field had such an area, and if it they have no the "learning school" for future extension of with simpler m er practice, great benefit would result, and an uncertainty as n to the many questions awaiting solution. But known to be be fers to put a whole large area under a so called acts, whether l and to incur risk and expense in giving it a account of the very dressing of *seet*, of bones, or other manure possibly even b previously ascertained by any trial on a small perties What t scale whether it is likely to succeed or not. If as much *seet* to put ld adopt the simple plan of making "com-

Indigo cultivat *on a small scale* at first, they would gain rotation being disp would repay the trouble over and over but the explanatio ame to applying the result to the larger in the power which happens is, that when the crop is ready to of assimilating at anter thinks about is to get it carted home interesting field of vats as soon as possible, and so the "experi-opportunities to the wall I know only too well that this is f experiments in England as well as in India, and the indigo planter in no way differs from the average

good English farmer, who, though he may be induced to start and to watch an experiment while it is in progress, yet fails at the last by not reaping the produce separately and weighing it, but allows "estimate" or "guess-work" to take the place of ascertained "fact," and recorded result. I know that there are difficulties to contend with, and that the separate reaping and weighing at harvest involve trouble which comes at the most awkward time, but I am equally certain that until planters will go to the trouble of seeking truth in the way which I have indicated, no definite progress will be made, nor the many questions affecting this important industry be decided

Unsolved problems in the manufacture of Indigo

349 If the remarks which I have made apply to the cultivation, similar ones might be made with even more force upon the *manufacture* of Indigo It is allowed on all sides, even by the planters themselves, that the manufacture, as at present conducted, is a mere "rule of thumb" one, and utterly unscientific in character So, indeed, I found it to be, though it is no easy matter to say off hand how it should be altered I saw enough to warrant me in saying that there is ample scope for improvement, for instance, in the replacement of a "rule of thumb" method by a strictly scientific one, one, that is, in which the details of every step are thoroughly understood. But, at the same time, I could see that it would not be done by any one coming as I did and simply throwing out a suggestion or two, but that it would require the aid of some one who had made a thorough investigation of the whole subject from the chemical side, and who could study each detail, ascertaining exactly what changes take place at each step, and then following these throughout until the final stage is reached The same difficulty which attends experiment in the field accompanies experiment in the factory There is the anxiety to get on as quickly as possible, the impossibility of checking any process when in actual operation and the preference to continue in known ways rather than to run the risk of failure with new ones And so, I fear, it will always be, until some one lays himself out to carefully work at the subject, and to experimentalise, so that the changes which take place and the conditions which regulate these changes may be fully understood The planter is not a man naturally of a scientific turn of mind, and he does not care to experiment in directions not understood by him The same causes, I regret to say, make him, not unfrequently, the victim of the pretensions or persuasions of men who, with some smattering, perhaps, of scientific knowledge, induce him to adopt this or that patented method of their own, assuring him that thereby he will distance his brother-planters in the quantity and quality of his out-turn. It is surprising what a readiness is shown by the planters to take up and to work for a time the invention of some adventuring so called "chemist," although previous efforts of the latter may be known to have proved disastrous failures. There is always some one ready to take on

Patents in Indigo manufacture

the new "patent process," and to embark upon it, in the hope that, out of the many plans that have been put forward, one at least must turn out a success, and that it will be his good fortune to secure that one chance out of the hundred

If planters, instead of endeavouring to gain an advantage one over the other, would only combine together to have the whole subject carefully worked out by a man of eminent scientific standing and of known integrity, the result might be attended with enormous benefit to the whole of the planting community, and the enquiry could be carried out at an infinitely lower cost than is now expended by individual planters or trading firms in abortive attempts to secure an advantage over their competitors.

350 To take some of the points in dispute It is still unknown which is the best way to pack the bundles of indigo plant in the steeping vats, whether, for instance they should be tightly or loosely packed Some planters support one view, others the opposite, while many maintain that the manner of packing is quite immaterial The kind of water which it is advisable to use is another matter for discussion It is argued, Packing of bundles in vats. Kind of water used.

essential or even desirable The superior quality of the "mark" of a particular factory is frequently put down to the kind of water used, and there is a general agreement that soft water is preferable to hard, and that muddy, stagnant, or foul water is prejudicial to the production of a good quality of indigo I have little doubt that the kind of water used is of material importance for soft and hard waters have very different extractive powers But it has still to be determined whether the matters capable of being removed from the indigo plant by the one kind of water and not by the other are conducive to a larger or better out turn or otherwise

The length of time which steeping should occupy is another debated point. Some say that the best colour is got by short steeping, and that though the quantity obtained may be less, the best paying result is obtainable in this way Others will steep for nine to ten hours, or even for as long as twelve and thirteen hours Duration of steeping

351. Over the question as to whether the cut plant should be steeped in water alone or with some chemical re agent, a great deal of speculation and a great deal of money have been expended, and so far with little result It is this stage which has been the principal field for the ingenuity of the "inventor" The use of nitre, ammonia, alum, carbolic acid, caustic soda, and other materials has been brought forward, and each plan finds some The use of chemicals.

planter or other who is willing to take it up from time to time, although as to what the action of the added chemical is, there is complete ignorance

The "beating" process

352. When we pass on to consider the "beating" process, the want of harmony between practice and theory is more than ever apparent. The accepted ideas of each are indeed almost diametrically opposed. What is effected by "beating" the indigo-containing liquid after it has been run off from the steeping-vats is very far from being known, and until some one of high chemical attainments can work at the subject, not simply in the laboratory, but also in conjunction with the actual manufacturing process, the real solution of the question will be very distant. The entire manufacture, from the beginning to the end, is one which should be intensely scientific, and should proceed on the most definite lines, instead of which it is, as I have described it, a "rule of thumb" procedure. To take a single instance. The time at which "beating" should cease is determined by a very rough test, the object of [illegible]

This may serve as a rough indication, but is not more, and it ought to be replaced by a chemical test which would indicate more certainly whether a quantity of indigo was being run to waste or not

The "boiling" process

353 After the m[illegible] ating-vat" and the supernatant [illegible] ely-divided indigo or "fecula" [illegible] But, here again, difference of op[illegible] be boiled once only, or twice, and also as to the temperature which it is best to employ in boiling.

The practical and the chemical views compared.

354. Dr Watt, in the able article which he has written on indigo in the "Dictionary of Economic Products," reviews fully the bearing of scientific investigation upon the manufacturing process, and emphasises the failure to apply the former to the latter. The main question, as to what "beating" effects, resolves itself into that of whether *oxidation* is produced in the beating-vat or whether the change is one of a purely *mechanical* nature.

The colouring matter contained in the indigo plant is a soluble glucoside termed *indican*, which, on maceration of the plant with water, is converted into *indigo-blue*, and this latter, on fermentation, is reduced to *indigo-white*.

The view of the practical man is that when the plant is steeped in the vat, fermentation takes place, *indigo-white* is produced, and in the "beating process" this is oxidised black again to *indigo-blue*. Consequently, several patents have been introduced with the object of facilitating fermentation and rapid oxidation, and they consist in the addition of substances, such as nitre, alkalies, etc., to the

converted into *indigo-blue.* But if the liquid as it enters the beating-vat is already finely-divided *indigo-blue,* there can be no use in putting oxidising materials into the beating-vat, and the change produced by the "beating" must be a purely mechanical one.

The chemist who has worked most at this subject is Schunck, in Germany, and he has [illegible] either for the decomposi[illegible] plant, nor for the format[illegible] see what good purpose [illegible] and possibly it may do h[illegible] cal science have led t[illegible] required at all, but that by simply macerating the plant with water or with a little acid, *indican* is extracted and is decomposed at once into *indigo-blue* and an indigo-sugar, called *indiglucin.* What is needed, therefore, is, not to assist, but to *prevent* fermentation the effect of which would be to decompose the *indigo-blue* into *indigo-white,* and necessitate its re-oxidation to *indigo-blue.* The process of manufacture as now generally carried out would appear to be this latter one, and to comprise really three stages, *viz.,* the formation of *indigo-blue,* the reduction to *indigo-white,* and the re-conversion to *indigo-blue,* whereas the chemical process would be a single one, *viz.,* the formation of *indigo-blue,* and its retention in this form by *arresting* fermentation.

355. It would be of little use were I to enter further into the discussion of what takes place, but I have said sufficient to show that at almost every stage of the manufacturing process there is an absence of any definite knowledge. This knowledge can only be obtained by the application of chemical science to the manufacture. In hardly any other branch of industry where chemical processes [illegible] made. Meantime chemists are busy in England, G[illegible]

The necessity for applying chemical science to the manufacture of indigo.

356. Undoubtedly there are improvements which can be effected in connection with the system under which indigo is cultivated.

Unsatisfactory conditions of indigo cultivation.

Under the *assamiwar* system (the one most generally adopted) the planter takes a lease from the *zemindar,* and the *raiyat* is

virtually a tenant of the planter, but is obliged to put a certain proportion of his holding under indigo each year for sale to the planter.

It must be acknowledged that indigo-growing under these conditions is not altogether a voluntary system on the part of the *raiyat*. He does not look on the indigo crop as he does on a food crop; there is not the same inducement for him to grow a good ... ates, either for a full-crop or for ... the actual yield. The *raiyat's* ... to give his worst land for growing indigo, whilst the planter's aim is to get the best land.

On the other hand, the planter has his own difficulties. For instance, he has a large capital invested in his manufacturing plant, while he is himself placed to a great extent in the *zemindar's* ... has to meet the ... e crop under the ... that of purchasing the plant from the *raiyat* by the bundle (the *khuski* system) he might not get sufficient crop.

The prevailing system, it is right to say, is not a creation of the English planter, he found it existing when he came, and has simply continued it.

Lastly, all alike, whether planter, *zemindar*, or *raiyat*, suffer from the non-existence of a proper Record of Rights, in which the areas of holdings and the rents charged should be clearly defined.

Tea.

Tea.

357. I took the opportunity afforded by my travels, of seeing something of tea cultivation both in the Neilgherries and at Darjeeling

... of too hurried a nature to enable me to do more than get a general insight into some of the questions which are waiting for solution.

Unsettled points in tea cultivation

358. There appears to be still a good deal of ignorance as to the elevation best suited to tea cultivation. Thus, in the Neilgherries, ... el, while in the ... y. In the Dar- ...

Then, in respect of the soil, little is known as to its requirements In the Neilgherr ... son to believe that a deficienc ... also, has had to do with the d ... On almost all sides there is but little known about manures, even about those which are available, such as oil cake and bones; the different oil cakes are classed together just as if they were the same and of equal value, it has not been established whether bones are useful,

whether green-manuring is advantageous, and still less on which lands the systems should be or need not be employed. The influence of particular fertilisers, such as nitre or other potash-containing manures, or else of phosphatic or nitrogenous manures, upon the quantity and quality of the tea is not definitely known. In regard even to tillage there are questions, for example, as to what depth of soil should be turned up, whether the land should be left in clods or be tilled finely, how far drainage is requisite, etc.

Unsettled points in tea manufacture.

359 The same kind of difficulties are met with in the manufacture of tea, and the delicate processes of drying, withering, rolling, fermenting, firing, etc , are carried on with an almost entire ignorance of the chemical changes which take place at each stage, [illegible] long [illegible] hered [illegible] leaf at the different stages are closely watched and taken as a guide, but this is very different to knowing exactly what does take place, and how to regulate each operation, so as to produce the best result.

Insect and other ravages

360. Another field of enquiry consists in the study of the insect and other ravages to which the tea plant is exposed, and in devising means for combating them.

The "red spider" (*Tetranychus bisculatus*) and the "tea bug" (*Helopeltis theivora*) are the main insect pests, and, as yet, no successful way of preventing their attacks has been found Mr. Wood-Mason in particular has given a great deal of attention to the study of the work of these insects At Darjeeling I found that "sulphuring" was largely made use of to guard against "red spider," but it was an expensive process, costing quite Rs. 20 an acre.

Appointment of chemist by Indian Tea Association

361 It is an acknowledgment of the importance of scientific inquiry in connection with the cultivation and manufacture of tea, that the Indian Tea Association have commenced a definite line of [illegible]

during the first year, this has had to do with enquiries as to the soils, cultivation, and manuring of the tea plant. It is now proposed to continue them for one year more, but more specially to devote investigation to the manufacture of tea

The insufficiency of the enquiry

I am far from saying that an enquiry lasting over 2½ years will not be productive of some good, but I am decidedly of opinion that the time is far too short to allow of the solution of any but a few of the many problems which have been sketched out for decision. It seems a pity that an enquiry affecting an industry of such importance and representing so much capital as the tea trade possesses, should be limited to so short a term

Proper method of enquiry

The first thing that a man coming out to take up a work of this nature must do, is, not to make discoveries off-hand or to invent theories, but to make himself thoroughly conversant with

what has been done before, both in the cultivation and in the manufacture It is only after this that he can be expected to usefully apply his scientific knowledge to the actual details This is a work, not of a year or two, but of several years, and it necessarily involves patient work and patient waiting, though sooner or later I am sure that the industry will reap the benefit, as others have done which have made use of the application of science to practice

Coffee

Coffee

362 My tour took me through some of the coffee growing districts of Coorg and Mysore, and, besides meeting a number of planters, I stayed some time with Mr R H Elliot on his coffee estate at Bartchinhulla, Munjerabad, where I had a good opportunity of learning about this industry

As compared with tea, the industry is a much simpler one, for the manufacture does not involve the careful manipulation that is requisite with tea, but the actual cultivation is a matter of equal importance in each case

Problems in coffee cultivation

363 I may briefly say that the same questions which I have alluded to as being still in dispute as regards the cultivation of tea, present themselves when dealing with coffee growing

The important matters of elevation, aspect, and shade, are by no means determined, nor are they attended to as they ought to be The nature and requirements of the soil have not been sufficiently studied, whilst there is much to learn in regard to manures, their use and relative values Lastly, there are diseases and injuries to which the coffee plant is liable, but which have not yet been successfully combated

Elevation

A suitable elevation, as in the case of tea, would seem to have much to do with the successful cultivation, though along with it must be taken the consideration of rainfall The Bartchinhulla estate is about 3 000 feet above sea level, and the rainfall is from 90 to 100 inches, but at Messrs Cannon's estate, where coffee of the highest repute is grown, the elevation is 4,500 feet and the rainfall is only 60 inches

Soil

The kind of soil, or rather, its earlier history, is a point of the highest importance If the land has previously been old forest land, thinned for the purpose of growing coffee, it is likely to do well, but if it be that which has before been under cultivation, more especially of the class known as *kumri* cultivation (in which the land is cleared by cutting down the wood, setting fire to the vegetation, and growing crops without manure of any kind) it is not nearly so valuable

Shade

The [illegible] aspect must be studied, chiefly in the matter of shade, while both the presence of shade and the kind of shade provided are most essential points Perhaps nothing affecting the cultivation of coffee impressed me more than the importance of shade I have been over estates where shade has been attended to, and I have noticed the healthy and natural growth of the bushes

I have also been to other estates where shade has been neglected and dependence has been placed upon heavy manuring. The

of shoots all up the stem. The indication of a good bush is, on the contrary, the healthy growth of new wood on the branches to form the fruit-bearing branches of the year to come. I have little doubt

and be so arranged as chiefly to protect the plant from the sun at every point during the hours when it is at its fiercest. It is recognised that trees differ very much in their suitability as shade-givers. While some supply but little leaf deposit for renewing the soil and spread out their roots along the surface of the ground,

their place.

The mechanical cultivation of the soil must be closely attended to, for it must be kept constantly stirred and not be allowed to get hard. To go on the land when it is wet is certain to do great harm. Perfect drainage is of the highest importance. Holes called "renovation pits" are dug on sloping ground in order to hold up the soil and prevent it from being washed away by the heavy rains in the

Tillage.

"Renovation pits."

work, and the
which, in the c
cut across and
think that the n
sary in order to
tice to regard these pits as means of bringing the subsoil to the surface, as well as of catching any wash, or of holding vegetable matter. It by no means follows that it is always an advantage to

growing this crop for some time, the produce declines materially, and it is clear that consideration ought to be turned to the manurial point of view of the cultivation, a subject which up to now has been quite neglected.

Tobacco

Tobacco.

367. The cultivation of tobacco is one on which great care is bestowed Like opium and sugar-cane, the crop carries with it considerable profits, but it is almost entirely grown upon good land and where both manure and water are available. Speaking generally, the crop is grown in rotation with other crops, but it is not unusual in some parts to grow tobacco year after year on the same land In Gujarát (Bombay) and Sind it is the common opinion that the quality of tobacco is much improved by the continuous growth of it for many years on the same spot, and fields can be pointed out which have produced tobacco for 40 years and more, and are specially noted, the produce often fetching quite "fancy" prices Manure is, of course, used lavishly. But this continuous growth of tobacco in certain districts is remarkable, and well deserves investigation, inasmuch as in other parts, for example, Khándesh and Belgaum (where the produce is also good), the cultivators will not take a tobacco crop oftener than once in ten years, alleging as the reason the impossibility otherwise of keeping down the parasite (*Orobanche Nicotiana*), which affects the plant so seriously (*see* later on, paragraph 372) Tobacco is grown principally as a "garden" (irrigated by wells) crop, but sometimes also as a "dry" (unirrigated) crop, the seed bed only being watered by hand I have instanced the preference of the grower of tobacco for particular kinds of water, and in paragraph 99 I have given an analysis of a well water which had the reputation of being specially suited to the crop I also mentioned in paragraph 133 that in some parts it is the custom to spread round the plants earth which is impregnated with nitre

The cultivation very careful

So far as the cultivation goes, I see nothing in which the *raiyat* can improve, for, like other "garden" crops, tobacco is one over which no trouble is spared It may be possible to get better information as to the effect produced by manures of various kinds, such as cattle manure, nitre, oil cake refuse, etc, upon the quantity and quality of the leaf, but this will hardly be the case so long as the Native uses his present crude methods of curing When, however, as is now beginning to be done in Madras, private firms turn their attention to the proper manufacture of tobacco and cigars, there will be the call for guiding the cultivation also in the most favourable direction

Manuring for tobacco

368. In Gujarát (Bombay) a great deal of tobacco is grown At Nadiad I met Rai Bahadur Becherdas Viharidas Desai, a most enlightened and leading agriculturist, who has given a great deal of attention and also money in attempts to improve the growing and the curing of tobacco. At the farm of the Nadiad Agricultural Association, of which Mr Becherdas

Experiments at Nadiad.

... experiments have been carried ... order to find the manure best ... us, the effect of the following manures was being tried at the time of my visit: cow-dung, goats'-droppings, castor cake, saltpetre, and tannery refuse. The general conclusions obtained thus far are, that saltpetre gives the largest yield, but does not produce a tobacco which is relished, and that for quantity and quality together, the best results are given by the goats'-droppings and by the tannery refuse. Mr. Becherdas Desai, in addition, has cultivated tobacco on a large farm near Nadiad, and has endeavoured to introduce the produce into the European market. Though the tobacco is pronounced by experts ... eable in ... echerdas ... without ... owing or in the curing. Finally, he has had to give up the attempt to create a European sale for the tobacco.

369. Curing of tobacco as conducted by the Native is done in a very primitive way.* The leaves are not removed one by one when ready for picking, but, after a few spots have begun to appear on the lower leaves, the entire plant is cut off close to the ground, and is left exposed to the night dew. Next day the plants are arranged in small circular heaps, about two feet high, with the stalks outwards. At the close of the day the heaps are opened, and the leaves are spread out for the night. The next day they are heaped again, and so on until after about five days they begin to turn yellow. Then the plants are hung upon horizontal poles for 15 to 20 days, the stalks being pressed close to each other. After this the leaves are again packed in square heaps, and these heaps are opened and re-packed every two or three days. The leaves begin then to sweat and finally to turn black. This blackening is a sign of fermentation being finished, and the leaves are then stripped off the stalk and tied up in bundles and baled. Often, crude molasses (*jagri*) and water are sprinkled on the leaves after fermentation is over.

Native method of curing tobacco

370. This process of curing is evidently a very crude one and admits of very great improvement. The curing of tobacco requires *every stage to be carefully watched*, the *temperature to* be observed, and fermentation to be induced or checked at the exact point which experience has determined as being best. Every leaf indeed should be treated as a unit by itself, and not simply as one of many leaves comprising a bundle or heap. But it cannot be expected that the Native cultivator will ever be able to do much more in this direction than he has done, and, wherever a better leaf is required, it will have to be obtained through the establishment of separate curing-places, such as those which have been

Improvement in curing

* This description is taken from a Report by Mr. H. Cane, of Madras (Bulletin No. 4, 1899-00, Agricultural Department, Madras)

started in the Madras Presidency, and which will be under the care of practised "experts"

Prospects of the industry

371. Endeavours have been made by Messrs Begg, Dunlop, & Co at Pusa in Tirhoot, and also at Ghazipur, North-West Provinces, to establish tobacco growing and manufacture for the European market Considerable advance has been made upon native methods, but it cannot be said that the undertaking has in either case been successful A fine or even fair quality of leaf has not as yet been produced, though whether the soil, the climate, or the curing, has been at fault has not been ascertained The failure to grow a high class leaf in the above places and also in Gujarát, may be due partly to the soil but more probably to the climate which is not sufficiently uniform throughout the year, but exhibits extremes of dryness and of wet at different periods For this reason the more regular warmth met with in Southern Madras and the greater freedom from extreme conditions may account for the larger measure of success which has attended the efforts in that Presidency to establish the manufacture on an improved basis and with the assistance of expert knowledge from other countries The prospects of the industry in Southern India are decidedly encourgiang

Tobacco parasite

372. The tobacco plant has a great enemy in the *Orobanche Nicotiana* or "*Bodu*," a vegetable parasite which grows out from the root-stock of the plant. It is an annual, but the seed is readily propagated and is hard to get rid of It is very certain that it attacks weakly plants by preference, and that it occurs on poor rather than on rich soil The only way to effectually remove it is to detach it from the tobacco plant before the seeding of the parasite has begun Being an annual its preparation may thus be prevented Thorough hoeing of the land is very necessary, and careful cultivation is said to keep it down (*see* paragraph 367)

Flax

Flax and Jute

373 Flax or linseed is grown in India entirely for the sake of the seed, and not for the fibre Indeed, experiments which have been made would seem to point to the ordinary linseed of the country being best adapted as an oil-giving and not as a fibre yielding plant It has been urged that considerable improvement in the preparation of fibre both from the linseed plant and from *san* hemp (*Crotalaria juncea*, which is not really a hemp at all) could be effected if men skilled in the manufacture could be obtained from other countries to teach the Native how to dress the fibre But more than this is involved. It would, firstly, have to be ascertained what kind of seed is the one best calculated to produce a good fibre rather than seed, and, secondly, the method of cultivation would have to be altered. In order to produce fibre, the plant must be sown thickly so as to grow tall and upright and not short and bushy, as is the case at present Further,

sown, the soil was found to blanch too much, and would not grow properly. When tried as a rainy-season crop, Mr. Ozanne found that it would not stand much wet, owing to its liability to a kind of "rust," and when tried as a cold-weather crop it proved to be exceedingly delicate. Again, the preparation of flax fibre is much harder than that of either the *san* hemp or of jute, and it needs skilled supervision and the employment of an "expert" in flax dressing. But the principal objection is that it is impossible to grow seed and fibre on the same plant; if seed be desired, the fibre must be sacrificed, and *vice versâ*. As long, therefore, as the cultivator gets a good profit by selling the seed he is not likely to risk the production of fibre, and if he is wanted to grow flax it must be made worth his while to do so.

Even as regards *san* hemp (the preparation of which for fibre is easier than that of flax), its place as a fibre has been virtually taken by jute.

374. At Serajgunge in Eastern Bengal I had the opportunity of seeing the cultivation of jute, and also its preparation and manufacture. The damp hot climate that prevails here especially favours the crop, and, inasmuch as it is mostly cultivated on rich inundated land which is constantly silt renewed, there is little need of manuring, as a rule. Occasionally cow-dung is used, or a pulse-crop is fed off previously to sowing the jute. *Jute*

Silk.

Silk

375. The decline of the Bengal silk industry is believed to be in great measure due to the spread of certain diseases among silk-worms. The worst of these is known as *pebrine*, and so serious have been its ravages that an effort was made a few years back to investigate its nature and the means of prevention. Mr N G. Mookerjee, o[illegible]
to Europe in [illegible]
tised in Italy [illegible]
with the system introduced by M Pasteur, of examining microscopically the moths intended for laying the eggs or "seed," as they are termed. The eggs of any moths which are found to be affected with disease are rejected, and only healthy "seed" is kept. It was hoped in this way to establish a pure race of silkworm free from [illegible] "seed" to silkworm-rearers [illegible] tral "seed-station" was sub-

It must be acknowledged, however, that the work has not been altogether satisfactory, and the steps taken in India have not been

successful in perpetuating silkworms which are free from disease, at least in the silk districts of Bengal. Mr Mookerjee, who has had charge of the experiments, has been able to rear silkworms free from disease in places such as Debra Dun which are far removed from the silk districts, but as soon as the seed is removed to the silk districts of Bengal *pebrine* appears and it is no longer possible to keep pure "seed"

Grain-cleaning.

Grain cleaning

376. The export of wheat and oil-seeds from India has introduced important considerations as to the cleaning of grain and seeds, and on these I wish to touch

"Dirty" condition of Indian wheat.

Indian wheat has, without doubt, acquired a name for being "dirty" and of being inferior to the Canadian and American wheats put upon the English market. It is stated that a considerable amount of earth, and of seeds other than wheat, come with the grain, and that this [illegible] the deliveries after their arrival [illegible] dian wheat has to be washed, partly [illegible] heat being very hard), and partly so as to get rid of the earth and dirt which are invariably found along with it A lower price consequently rules for Indian wheat, and many millers who would be willing to purchase it are kept back from doing so by reason of the expense involved in providing special appliances for cleaning the grain

The basis of sale of wheat

377 It has been customary to sell Indian wheat on the basis of its containing a certain amount of impurities, the exact amount varying with the place of export and the time of year when export takes place. In the case of Calcutta wheat, 5 per cent of impurities used to be allowed for ante monsoon shipments (previous to 1st July), and 6 to 7 per cent for post-monsoon shipments (after 1st July) For Bombay wheat a somewhat lower percentage, *viz*, 4 to 5 per cent was allowed, but wheat from Karachi was reckoned as being more impure than that from Calcutta or Bombay, and the ante monsoon season also extended to 30th September.

The causes of wheat being shipped in this impure condition were alleged to be the inferior cultivation of the Indian *raiyat*, the habit he has of growing wheat, not alone, but as a "mixed" crop, and the imperfect means at his disposal for threshing out and cleaning the grain It was argued that as the cultivator threshes his corn by treading it out upon an earthen floor with his bullocks, the earth must of necessity get mixed with it, besides this, that the means of sifting out foreign seeds being crude, and the *raiyat* having no machinery for the purpose, impurities arising from the crops grown along with the wheat must prevent a good clean sample from being obtained.

How Indian wheat comes to be dirty

378. That a certain amount of foreign seeds and dirt finds its way into Indian wheat from the above causes is undeniable, but as I shall presently show, this does not account for

anything like the percentages of "dirt" which it has been the custom to fix. When first the export of wheat began to assume any considerable dimensions the purchase of shipments was conducted on the system of "mutual allowances," the buyers paying for any superiority in cleanness shown above the arranged limits and the shippers paying for any deficiency Samples of the different cargoes were subm[illegible] England to the Corn Trade Association for anal[illegible] thereby But it [illegible] that had been mad[illegible] wheat generally arrived in so clean a condition that the buyers had in most cases to pay for the extra cleanness They soon got tired of doing this, and accordingly dropped the system of mutual allowances They resolved only to purchase upon the basis of "fair average [illegible] allowance for any inferiority shown, leaving the exact amount to be settled by arbitration.

The result of this action soon made itself apparent. Indian wheat, which up till then had been coming over clean, now began to deteriorate, and the London or Liverpool buyer talked loudly of its "dirty" condition, and assigned this as a reason for giving a lower price for it than he would for Canadian, American, and other wheats But the change in the character of Indian wheat was the direct consequence of the English buyer's action, inasmuch as the Indian shippers finding that they no longer got a penny more for wheat which they sent over clean than for that which had the full allowance of impurity, naturally took good care not to ship any which had not the full amount of impurity This has led to a deliberate system of adulteration of wheat being practised, and, however pure the grain may be when it comes off the cultivator's field, it is always *made up to* "fair average quality" as understood in the English market, before it leaves the place of export

Local adulteration

[illegible] ported grain was those interested [illegible] d who had been [illegible] before Viscount Cross, the then Secretary of State for India, much valuable information upon the subject Messrs McDougall's enquiries elicited the facts that not only was clean Indian wheat desired, but that an extra price would be paid for it, and increased use be found for it The desire of the millers was that admixture should be limited by contract to 2 per cent.

Attempts to secure purity of Indian wheat

Reports and papers were laid before Parliament in 1888 and 1889, and on May 8, 1889, Viscount Cross presided at a Conference

Conference at the India Office

held at the India Office to consider the question of Indian Wheat Impurities. In the course of his opening address his Lordship pointed out that no less than three million cwts. of dirt are imported every year with Indian wheat, and that this implies a useless and foolish expense.

The London Corn Trade Association on their part maintained that the condition of Indian wheat was a natural one, due to the methods of the *raiyat* in cultivating and threshing, and that the basis of 4 per cent of impurity for Bombay and 5 per cent. for Calcutta wheat was accepted by shippers as being the normal condition of wheat as grown Shipment on a 2 per cent basis, they maintained, would imply cleaning at the place of export, and would necessitate English millers paying a proportionately higher price which they would not be found willing to do. The London Corn Trade Association raised objections to selling wheat on analysis, (in the same way that linseed is sold), and they deprecated Government interference in a trade matter which would gradually right itself and effect the desired improvement in time.

Views of Liverpool Corn Trade Association

The Liverpool Corn Trade Association differed entirely from the London Association, and saw no difficulty in fixing a 2 per cent "refraction" standard, at least for Bombay wheat, they believed that if a 2 per cent limit were fixed in England, the wheat would soon come from India of the required purity The term fair "average quality" they felt, was a very elastic one

Views of millers

A point of considerable importance was raised by millers in the Midlands and other inland counties of England They pointed out the disadvantage they were at in having to pay not only for the extra dirt, etc, coming from India to London, Liverpool, or other English ports, but that they had to pay as well for its conveyance at high rates along English railways In this way the smaller millers and those inland were much prejudiced, for they could less afford than the larger millers to put up the requisite machinery for removing the impurities which had been deliberately put in, and for which they had had to pay extra carriage

It was not to be expected that any general agreement could be come to at the Conference, when interests so divergent were concerned but, although a few large millers, who had already gone to the expense of setting up special machinery for dealing with Indian wheat were in favour of matters remaining as they were, the National Association of British and Irish Millers, and millers generally, strongly urged that improvement ought to be effected, that wheat should be shipped cleaner, and that wilful adulteration should be punished

Attempts made in India to supply clean wheat

Bengal Agricultural Department

380 In India itself, enquiries were made, and efforts were put forward to induce a trade in clean wheat The Reports of the Bengal Agricultural Department showed that the unsatisfactory state in which wheat was exported was not due to the inferior cultivation and dressing which it received from the *raiyat*, but that when clean wheat was offered the merchants owing to the action of the buyers in England, positively declined to give any better price

for it than for wheat with 5 per cent. of impurities. Mr. Finucane, Director of the Ben ... es that in August 1887 the ... to grow wheat largely and ... uld get a ... *rayats* advances ... wheat alone and ...

agent of a leading wheat-exporting firm, and that his servants were instructed how to make little pellets out of mud and water, which would resemble wheat, and to mix 2 maunds of this earth with every 100 maunds of grain whenever the wheat was found not to contain 5 per cent. of impurities.

381. The Bombay Chamber of Commerce have repeatedly urged the London and Liverpool Corn Trade Associations to accept a basis of 2 per cent. of "impurities," and have said that, were it adopted, there would be no difficulty whatever in getting *any quantity* of wheat cleaned to that extent. To these proposals the Liverpool Association seemed to be favourable, but the London Association declined to assent. In place of it they proposed, in November 1889 the following "refraction" limits for ante-monsoon shipments 3 per cent. for Bombay wheat, 4 per cent for Calcutta wheat, and 5 per cent for Karachi wheat. Of these "total impurities" about 1½ per cent was to "be dirt." *Somewhat higher percentages were fixed for post-monsoon shipments. The Liverpool Association joined in the recommendations. In vain the Bombay Chamber pointed out in reply that the analyses of Bombay wheat, as given by the Official Analyst of the London Corn Trade Association, showed even less impurities than the latter Association proposed, but so the matter stands.

Proposals of Bombay Chamber of Commerce.

Replies of London and Liverpool Corn Trade Associations.

382. I was naturally desirous of forming my independent conclusions upon the question of clean wheat, and therefore made my own enquiries. Mr John Marshall of the Bombay Chamber of Commerce, Mr Wishart (Cawnpore), Mr H M Ross (Calcutta), and others, kindly gave me much information as to the practices of the trade; but, in addition, when pursuing my general enquiry up-country, ... each ... wheat ... grades ... of all ... more ... ation, ... each ... I am ... English merchants really want to have clean wheat, they have only

My own enquiries.

* The term "dirt" includes earth, chaff, and miscellaneous weed seeds of no [illegible].

to insist upon its being supplied, and it would at once be forthcoming.

Adulteration of wheat seen by me.

Any doubts that I may have had as to wilful adulteration of wheat being practised were set at rest by my seeing, as I was passing Changa Manga railway station (in the Punjab), a large heap of wheat being deliberately mixed with earth. This was going on in full view of everyone.

The quality of wheat from the cultivators threshing floors

383. My attention was next directed to ascertaining how the impurities that are found in wheat exported to England find their way into the grain For this purpose I endeavoured to find out what the quality of wheat is as it leaves the threshing-floor of the *raiyat*, whether, in fact, it *does* contain all the dirt that it has been represented to have, for instance, the mud from the threshing floor, and the gram and other seeds from the "mixed" crops grown with the wheat.

Accordingly, when staying at Cawnpore with Mr. Holderness, Director of the Agricultural Department of the North-West Provinces and Oudh, I obtained through his Personal Assistant, Mr Lachman Parshad, six samples of wheat which were taken, according to my detailed instructions, direct from the threshing-floors of cultivators in the neighbourhood of Cawnpore, and just as the wheat was about to be sent to the nearest *bazar* for sale The wheat was accordingly in the state that it left the cultivator, and as it passed into the hands of the local traders for transmission to agents of the large wheat-exporting firms, and for subsequent despatch to the port of shipment.

The heaps of wheat as they lay on the threshing-floor, ready for removal and sale, were carefully sampled by turning each over and drawing from it handfuls from different parts, turning it over again and taking fresh handfuls, and so on, until an average of the whole was obtained, which, by subsequent division and sub-division, was reduced to a lesser bulk. The final samples were sent to me and the separation of the wheat and the impurities was carried out in my presence, the results of the separation were as follows:—

TABLE XIII.

Mechanical Analyses of Samples of Wheat taken from Threshing-floors of Cultivators in the Cawnpore District. Mechanical analyses of samples of wheat

No.	Village	Impurities				Clean Wheat
		(a) Gram and other Pulses with Large Earth	(b) Barley Chaff Immature Wheat etc	(c) Rape Small Weed seeds and Fine Earth	Total Impurities	
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*
1	Binaitpur .	—	—	—	15	99 85
2	Cawnpore .	·35	1 18	·24	1 77	98·23
3	Gotaya . .	·20	1 34	·24	1 78	98 22
4	Likhanpur .	·16	1 72	·28	2 16	97 84
5	Rawatpur .	—	·68	·03	·71	99 29
6	Nawabganj	—	1 11	12	1·23	98 77
	Average of six samples . . .				1 30	98 70

NOTE —No. 1. This sample was exceptionally clean and the impurities were too small to [illegible]

Other details of the Analyses are given in Appendix N.

From my own inquiries, therefore, I am convinced that the wheat, as it leaves the *raiyat's* threshing-floor, contains only about 1½ per cent. of anything but wheat, and that there would be no difficulty whatever in supplying clean wheat on a basis of 2 per cent. "refraction," if only it were wanted.

There is another significant feature, namely, that if the earth that is so much complained of came from the threshing-floor, it would much more probably be the fine crushed earth and not the small lumps which are so generally found in imported wheat. The case of wheat is different to that of linseed, for, while the latter is generally *pulled up* by the roots along with their adhering earth, wheat is, as a rule, *cut* and not pulled.

384. The charge against the *raiyat*, that he sends dirty wheat into the market is, accordingly, not substantiated. What really happens is, I believe, that the traders or middlemen between the cultivator and the exporter all have their profit to make out of the wheat as it passes down to the place of export This they do, as I myself saw being done at Changa

The real way in which "dirt" get into Indian wheat.

Mangi station, by mixing earth or foreign seeds with the wheat. The middlemen take good care that the cultivators send them the wheat clean, otherwise they would not be able to make their own profit out of it, and if the *raiyat* delivered the wheat to them dirty they would refuse to take it. But, as the grain passes on from hand to hand, each man makes his little profit by mixing other material with it, and finally it reaches the place of export, here it is *made up* according to the requirements of the trade with each country, and thus in the case of wheat sent to England, the 5 or 6 per cent of impurity, necessitated primarily by the action of the London Corn Trade Association, is gradually added, shipped to England, and on its arrival has all to be taken out again.

That this is what really takes place was forced upon me still more strongly by an examination which I made of a sample of wheat taken from a bulk in Cawnpore market, exposed for sale there. This bulk I saw myself, and had a large sample of it drawn, and the impurities were sifted out and weighed in my presence. The results were:—

Analysis of wheat from Cawnpore market

	Per cent.	
Clean wheat	96·37	
Barley	·88	3·63
Gram, *dal*, and other pulses	1·56	
Small barley and chaff	·44	
Rape, unripe wheat, earth, etc.	·75	
	100·00	

This wheat was of the description known as "No. 2 Club."

A noticeable difference is found between the amount of impurities in the sample from Cawnpore market and that in the samples from the cultivators' threshing floors in the surrounding district. This tends to support the view which I have expressed, that the impurities find their way in as the wheat passes from hand to hand.

I found also that at Cawnpore the refuse from the flour mills in the town had a substantial value in the market.

The fault lies with the home buyer

385. I lay the blame for the impurity of Indian wheat not upon the *raiyat*, nor yet upon the exporter, but upon the home buyer, as represented by the London Corn Trade Association in particular. The home buyer *does not want* to have pure wheat. If wheat were sold on the basis of absolute purity, this would lead to more arbitration upon samples, and would minimise speculation. If a margin of 4 or 5 per cent of impurity is given, the buyer will look at a sample and judge very fairly whether it has 3 per cent of admixture or more than this, but if the basis of sale were "absolute purity," or else 1 per cent of impurity, there would constantly be arbitration as to the exact amount, and the buyer, instead of as now getting a delivery sometimes better than usual, and

The inducements to keep up the present system

being able to resell it at an advantage, would have the element of speculation removed and only be able to sell on the certified quality.

The presence of admixture in Indian wheat keeps its price below that of Canadian and other wheats, and thereby offers the inducement of a lower price to buyers, and promotes speculation So long as the term "fair average quality" is retained, the meaning to be attached to it will be a very elastic one

Undoubtedly, too, not only are the merchants opposed to any change in the existing practice, but there are also large millers to whose interest it is to keep Indian wheat "dirty." They have put up extensive and costly machinery purposely to enable them to deal with Indian wheat, and, being able to buy the latter at the lower quotation, they secure an advantage over their smaller rivals who cannot go to the same initial outlay.

The elevator system

386 It has been suggested that if the "elevator" system, which is in ... were to be introduced into India, ... ulk and be graded at the differe ... sell according to its ascertained quality

Inapplicable to India

But there are difficulties which make the system inapplicable to India Apart from the undesirability of subsidising, as has been suggested, any private firm for a term of years to carry this scheme out, and apart from the impossibility of Government taking in hand the whole wheat trade of the country, there are considerations as to the nature and methods of cultivation which place Indian wheat on a different footing to that of other countries In the first place, Indian wheat will not *keep* for any length of time, but is liable to the attacks of weevil, it is thus much better suited for bagging than for keeping and selling in bulk Secondly, the number of different kinds of wheat grown is so large, and the individual areas over which they are distributed are so small, that to grade these numerous small lots would be a difficult if not impracticable task. In America and in Russia, for instance, we should find one si ... nt of country, but in India the ... e kind in one field, another in ... wheat there *Altogether, some thirty different descriptions of wheat are sent from India to Europe*

The remedy to abolition of fixed rates of refraction

387. The real remedy for the condition of Indian wheat will be found in the abolition of fixed rates of "refraction" As long as these are maintained the exporters will *work up* to them but if the English buyers say that they must have clean wheat it will be speedily forthcoming France and Italy have both refused to receive dirty wheat from India, and the consequence is that they have it sent to them clean Russian barley is sold on a basis of 3 per cent of impurity, and this plan works quite smoothly When clean linseed was insisted upon by Calcutta merchants the *raiyats* up country soon began to screen it and to deliver it clean At one time the same difficulties that exist with wheat occurred also with rice, but these have been now removed, and rice is sold on a "pure" basis

The same might be readily done with wheat if the trade really wanted to have it clean.

Legislation may be necessary

If, however, the trade are not willing to set the practice right themselves, there only remains the enforcement of legislation to oblige the sale of wheat on a "pure" basis, and to make it a penal offence to adulterate wheat, or to export or trade in adulterated wheat.

The trade, and in particular the London Corn Trade, have the power of remedying this themselves, but they have shown little disposition to do it, and it is, I think, time that stronger measures should be taken to oblige them to put the Indian wheat trade upon an honest basis.

Linseed

Linseed.

388. My inquiries on the matter of grain-cleaning extended to linseed as well as to wheat

A 1 ... me in the Central Pr ... tlement Officer at Da ... Fuller's (Commissioner of Settlements and Agriculture, Central Provinces) staff. Most of these samples were taken direct from the cultivators' stores or threshing-floors, and in the manner described before. The samples were brought by me to England, and the mechanical analyses were performed in my own laboratory In Appendix O I give the detailed results of analyses of 39 samples collected from different districts.

Mechanical analyses of samples from cultivators' stores and threshing floors

The seed was first passed through a course sieve which retained all coarse earth and large seeds, then through a finer sieve which retained the linseed, allowing the fine earth and small seeds to pass through The amount of "sieved linseed" was thus obtained Finally, the sieved linseed was hand-picked, and everything was removed that was not "pure linseed." The following table gives the summary of the results —

TABLE XIV.

	Pure Linseed (hand picked).	Total Impurities.
	Per cent	*Per cent.*
18 samples from Bilaspur district	93 8	7 13
4 „ „ Raipur „	93 94	6 06
2 „ „ Jubbulpore „	95 81	4 19
3 „ „ Damoh „	91 60	8 40
11 „ „ Nagpur „	95 79	4 21
Average from all districts	94	6

Further details of the analyses are given in Appendix O.

To one sample in particular (No. 31 in Appendix O) I would refer. This is one from the Nagpur district, and was taken at Messrs. Ralli Brothers' store, or "godown," from linseed which had been brought in in carts for sale at the "godown." Linseed at Ralli Brothers' store

It gave—

	Per cent	Per cent
Coarse earth and large seeds .	63	
Fine earth and small seeds	1 18	
Stalks, chaff, etc., removed by hand picking	85	
	2 66	
Total impurities .		2 66
Pure linseed . . .		97 34
		100 00

The different samples give varying amounts of impurities, but, on comparing the results with those obtained in the case of wheat, it will be noticed that the average amount of impurity is higher when linseed is the crop. This is but to be expected, inasmuch as the linseed is generally gathered by pulling up the plant bodily with the roots and adhering soil, also the foreign seeds, short stalks, and chaff, are much harder to separate from linseed than they are from wheat. Yet it would appear from the results given above that when the merchants want well-cleaned seed, they can get it readily enough.

389. I ascertained at Bombay that the usual plan followed in buying linseed for export is as follows:—The seed is bought from the up-country *raiyats* by the dealers, the latter bring it to Bombay or some other port and place it in the *bazár*. An intermediary called the *muccadam* buys the seed in the *bazár* and cleans it; he brings samples to the various seed shipping firms, and covenants with them to supply a certain amount like the sample, of a definite percentage of purity and at a certain fixed price. The linseed is generally bought in India on a basis of 94 per cent. purity, and is sold to buyers in London and elsewhere on a basis of 96 per cent. The *muccadam* is responsible for the purity, and if, on arrival in England, the seed is found, according to the test of the Oilseed Association to come out below guarantee, an allowance is made for it, and the *muccadam* has to pay this to the shipper. But if the English buyer gets a seed of higher purity, he is not called on to pay for anything above the guarantee. Accordingly, the shipper's *chance* the deduction being made for Method of purchase and export of linseed

are not to send any seed

linseed was bought on

ing more for the cleaner

seed, and being allowed for that which was less clean. This clause, however, was eliminated by the home buyers, and at once the quality of linseed deteriorated, as it was no longer to the interest of the exporter in India to get pure seed.

[illegible]

At [illegible]

[illegible]

With [illegible] that willing [illegible] will [illegible]

CONCLUSIONS.

390 The improvement of particular agricultural industries, such as those connected with sugar, indigo, tea, coffee, tobacco, etc, would benefit agriculture generally But the carrying on of these industries is, as a rule, confined of necessity to certain particular localities, and cannot be indefinitely extended over the country Improvement in agriculture, through the modification of differences in practice, can have, therefore, but limited scope It is rather to a bettering of practice in each industry that attention must be directed

In sugar cultivation and manufacture, however, there are clear cases in which better methods are employed in some districts than in others, and it would be within the power of Agricultural Departments to extend the knowledge of the better practice It is very certain that sugar cultivation might be very much extended, and that by better ways of dealing with the canes and with the expressed juice the out turn of sugar might be largely increased, and India become less dependent upon the importation of foreign sugar

Beyond the work which Agricultural Departments can do in demonstrating the advantages of certain modes of cultivation and of approved implements such as the iron sugar mill and the shallow evaporating pan, there are numerous questions affecting the production of sugar which can only be solved by the application of chemical science So much work is there to be done in determining the causes which influence the out turn of sugar, that it almost warrants the employment of a chemist for this industry alone

The indigo industry is one which pre-eminently calls for the assistance of chemical knowledge, and for its application to the processes of the manufacture at every stage In perhaps no other industry where chemical processes are involved is so little known of their nature or how they may be controlled A skilled chemist should be set apart for this work alone

This is, however, a matter, not for Government, but for those engaged in the indigo trade

The quality of Indian cotton is no doubt inferior to what it used to be, but the cause is the demand for cheapness, and the remedy is not with the *raiyat*, nor with the Government, but with the trade. It is advisable that seed of the better varieties of cotton should be preserved in case of a demand arising for them in the future, also, it would be very desirable to secure by recognised trade-marks the various kinds of cotton which are grown, Government can, however, do but little else

In the cultivation and manufacture of tea, there are many points which call for the aid of the chemist This has been already recognised by the Indian Tea Association The same applies in some degree to the cultivation of coffee, and still more so to the curing of tobacco The employment, however, of the necessary scientific assistance is a matter for those engaged in the particular industries rather than for Government.

The fact that the Indian wheat imported into England has the name of being "dirty," arises, not from bad cultivation or from carelessness on the part of the *raiyat*, but from the action of the English Corn Trade Clean wheat is not desired by English buyers, and exporters consequently make up their cargoes to the requirements Wilful adulteration of grain consequently takes place in India If clean wheat were wanted it would be at once forthcoming The elevator system is not applicable in the case of India The remedy for "dirty" wheat will be found in the abolition of fixed rates of "refraction," but, unless the trade itself adopts the remedy, it will be necessary to make adulteration of wheat a penal offence, as also the export of, and trading in, adulterated wheat

RECOMMENDATIONS

RECOMMENDATIONS.

391. I recommend —

The setting on foot of Enquiry by Agricultural Departments in order to ascertain the best methods of cultivation and manufacture of crops, such as sugar cane, indigo, tea, coffee, tobacco, etc , and the endeavour, by demonstrating these methods, to extend the cultivation and increase the out-turn

The employment of chemical science in the investigation of problems affecting these industries, and more particularly that of an Agricultural Chemist in connection with the sugar industry

The making it a penal offence to Adulterate wheat, or to export, or trade in adulterated wheat

...all holdings and small ... capital.

...an's ... nly ... ughly ...ps, and

...st for rich Sugar-cane ...ly on tens of ...re spent to grow

obtaining or the , as well as the ...ucts of superior imple- employment of better cattle It has been rightly what is wanted is not increased in the *number* of five-... farms, but more *capital* put into the existing ones " It is not as if we were dealing with farmers occupying some two or three hundred acres each, and where capital, education and enterprise are present, but it is the absence of these, and the sub division of the land into small patches, that make the problem of improvement so hard a one.

395 The conditions under which land is held in the different provinces of India have important bearings upon the agriculture ...nder the *raiyatwari* system of Madras, for example, the State ...ls directly with the peasant proprietor, and the latter, so long ...he pays the assessment which has been fixed, is able to do with ...land as he likes This, however, as Mr Nicholson points out, ...gets a tendency to rent out the land to others, and to live upon ...he proceeds Land may thus become the object of competition, ...nd rich merchants frequently buy it as an investment, handing ...over for cultivation by poor tenants who are themselves unable ...put any capital whatever into it There may, in this way, be ...due extension of cultivation, the *raiyat* (here really a proprietor) ...ng allowed to take up any quantity of land, regardless of ...ther he can do justice to it or not. A proprietor (*raiyat*), so ...as he pays his fixed assessment, is able to rent his land to ...tenants at any figure which he can obtain, and the sub-tenants ...re really tenants at will, liable to be turned out by a higher ...r There is consequently, a disinclination on the part of the ...n tenant to put money into the land as, for example, by sinking ...well, whereas, to the proprietor there is the inducement to get ...e profits of a petty landlord rather than those of the hard working cultivator.

Systems of land tenure

On the other hand, a great deal of land is cultivated on the *metayer* or sharing system, the tenant paying for the cultivation

and taking one-third or one fourth of the produce and all the straw, and handing the remainder over to the landlord, the latter paying the Government assessment The interests of tenant and proprietor thus become one

Other systems prevail in other parts, each with its special advantages or disadvantages, but into these I must not enter, *nor yet into the vexed matter of the influence of a permanent* settlement as opposed to that of a re-settlement at intervals of 20 or 30 years.

Indebtedness of cultivating classes

396 The natural indebtedness of the cultivating classes, and their recklessness in the matter of marriage expenditure and in litigation, are features which affect most seriously the possibility of improving the agriculture But here, again, I am on ground where I can make no useful suggestion, and on subjects which have for long engaged, and now are more than ever occupying, the earnest attention of Government By the introduction of the *taccavi* system of advances, and by loans for the purchase of seed, cattle, etc, in time of scarcity, the State has endeavoured to afford advantages to cultivators But the latter have not as yet fully availed themselves of these advantages, the chief reason in most cases, being that they are too deeply in the hands of the *baniya* or money-lender to offer any security for the advances made The *baniya* is also the grain merchant, and it is he to whom the cultivator resorts for the seed which he needs before his crop can be sown The *baniya* advances the seeds, generally at exorbitant rates of interest, 25 per cent for six months being quite an ordinary rate But the cultivator *must* have the seed, and, having kept none ove for himself, he resorts to the grain merchant and thus a crop is often mortgaged even before it is grown The sums spent by cultivators in marriages and displays are enormous when compared with their incomes, and for these, as well as for what they require in litigation, the *raiyats* repair to the money lender So long as there is anything on which security can be given, be it crops or be it land, the *baniya* is willing to advance, and when once in his hands it is seldom that the borrower comes out again The accounts thus opened are rarely closed, and increase with astounding rapidity, interest being added to principal, and becoming the new principal. On interrogating cultivators in villages in the Central Provinces, I frequently found that there was not one who was not in debt to some extent or other, and yet this was not because of the poverty of the soil or the inferiority of the crops It was a habit, and one carried to such an extent, that even those who were well able to purchase their seed went, nevertheless to the *baniya*, if only to keep up friendly relations with him In one case I found that an original debt of Rs 120 had in a few years mounted to one of Rs 600, a decree had been obtained against the borrower, but there was not the least intention of enforcing it, and it was elicited also that the same cultivator had already spent Rs 400

Money lenders

Marriage expenses and litigation

Indebtedness almost universal

in weddings, and was now about to spend another Rs 50 in order to marry off his son.

Near Cawnpore I came to a village owned by four *zemindars*, holding 2,600 *bighas* (*bigha* = ⅝ *acre*) between them. All four were more or less in debt One owed Rs 5,000 and had mortgaged his land, paying 10 annas for Rs 100 per month, a second had had several lawsuits, and had given the *baniya* a mortgage, the principal and interest to be repaid in ten years, a third had found an existing debt on the property when he came into it, and the fourth was Rs 10 000 in debt It was clearly impossible for these men to do anything to improve their tenants' position The *zemindars* often are too encumbered to lay out money for well digging or for water supply by tanks In parts of Chota Nagpur and the Central Provinces the forests have been cleared in consequence of the indebtedness of the landed proprietors, and in order to provide the latter with ready cash In these ways the land passes from its hereditary possessors and falls into the hands of the money-lenders In Thána (Bombay) almost all the land has become the property of non cultivators In the Hoshiarpur (Punjab) Settlement Report it is stated that—

Indebtedness hindrance to improvement.

"owing to the pressure of population and the special tendency to litigation and to spending large sums on marriages the district is loaded with a [illegible] last 30 years has been [illegible] ent and 4 per cent [illegible] the rural population

In the Central Provinces the amount of indebtedness is deplorable, and here it is the "absolute occupancy tenant" who suffers most, as he possesses the most rights, and they favour credit being given The cultivators are as a rule, comfortably off, and their being in debt is mostly the result of their ability so give security To have a large sum in the *baniya's* book is, indeed, considered a sign of prosperity, and the possession of good credit The existence of the *baniya* is the *result*, and not the *cause*, of the indebtedness of the *raiyat*, and amongst the surest signs of real poverty are the paucity of *baniyas* and the absence of jewellery on the females The habit of getting into debt is strengthened by the almost total absence among the cultivators of any system of keeping accounts of income and expenditure

397 The remedy for indebtedness is not the extermination of the *baniya*, even were that possible, but it will be found in an increased general prosperity, which will make the people more self reliant and independent Mr R H Elliot, of Munjerabad, Mysore, told me that formerly the cultivators around his estate used constantly to come to him to borrow money, to pay the Government tax (he lending it to them without interest), so that they might not increase their indebtedness to the *baniya*, but that more recently, by having their own patches of land in coffee, and by working in plantations, the cultivators had,

Remedies for indebtedness

to a great extent, become free of the *baniya*, and now rarely came even to him (Mr. Elliot) to borrow money.

Mutual benefit society at Hospet.

In a few cases the people have combined for mutual protection against the exorbitant charges of the money-lenders. In Hospet (Madras) a Mutual Benefit Society has been established in consequence of the money-lenders charging as much as 24 and 30 per cent interest. The founding of the society has brought the charges of the *baniyas* down very considerably.

Messrs Thomson and Mylne's action at Behea

At Beh[illegible]

[illegible] absolute necessity that there was of being on the spot, and of knowing all the circumstances of the individuals who applied for loans.

Measures to curtail money lenders action.

In [illegible] to adopt stringent measures [illegible] It would certainly seem [illegible] quiries should be made not [illegible] the history of these debts. [illegible] rding to an old Hindu law, no greater arrears of interest could be recovered at any time than amounted to the principal sum, and he thought that this rule might well be revived. Mr. Fuller was also in favour of Government granting loans to cultivators in some parts of the Central Provinces where good security was undoubtedly present, to enable them to pay off their debts to the *baniyas* Their past experience of the extortion of the money-lenders had been so bitter that they would, Mr. Fuller thought, avoid its recurrence in the future if they could once be set free from it.

In the Saugor district of the Central Provinces the land belongs almost entirely to money-lenders, and, in consequence of the way in which the *raiyats* were ground down, the plan was devised of alleviating them by giving a lower assessment to the proprietors, provided that they undertook in turn to charge less to their tenants. This plan Government approved.

But the same remedy will not apply in one Province that does in another, and each will have to be dealt with according to its particular circumstances.

Want of enterprise

398. Next to indebtedness and extravagance comes, as a drawback to agricultural progress, the *want of enterprise* sometimes met with among cultivators. Mr. Nicholson says of Coimbatore —

"There is a low level of social comfort, and the desire for progress is prevented thereby, there is a disinclination to economy in time and land, or to exertion in unusual times and seasons. The tendency is to rent out the land, and to live on the proceeds"

Of Anantapur Mr. Nicholson writes :—

"The total absence of effort and determined struggle, except on the old lines, on the part of the people, is the cause of poverty"

This lack of enterprise is not always the result of the hardship of circumstances or the poverty of the soil Frequently it may

be the precise reverse. The Central Provinces have been described as a country of "rude plenty." The soil naturally produces enough to make the people comfortable, and for more than this they do not care. I have described in an earlier chapter (Chapter III, paragraph 23) how improvement in circumstances might be produced were the cultivators in the wheat-growing districts to raise other crops than wheat. But they get all that they want, and their wheat gives them only about two months' or three months' work, at the most, whereas, if they grew other crops, they would have to work more, and also to irrigate the land. They are ready to admit that embanking of land (*bunding*) does good, but they will not go to the trouble and expense of doing it until positively obliged. As compared with the North-West Provinces, the density of population is 400 or 500 only to the square mile of cultivated land, as against 1,090, but the produce of wheat per acre is less than in the North-West. Were enterprise present, the wheat produce in the Central Provinces might be much more than it is. Assessment, too, is low as compared with the North-West, but a low rate of assessment is by no means synonymous with prosperous agriculture. Of many parts of the Central Provinces it might be said that, were the assessment higher, the agriculture would improve, in order to enable the increase to be met. Around Damoh the people have been obliged to embank their land so as to make the crops pay. It is certain that there are many parts where an increased difficulty of living would bring about improved practice of agriculture. It is not where population is least dense that the best agriculture is seen, but more frequently in the most congested districts, such as those around Benares, Azamgurh, and other parts of the North-West Provinces. As the struggle for existence becomes harder, there is the inducement to put forth effort to meet its demands, whereas comparative ease in circumstances, a light assessment, and a naturally fertile soil, may prevent the exercise of energy, and may foster a backward condition of agriculture. Where such is the case an improvement can only be expected to come from the disturbance which time or pressure of population will make in the easy circumstances which exist.

Natural advantages and easy circumstances not conducive to agricultural improvement

399 Attention has of late been turned greatly to the subject of the export trade in wheat, and it has been debated whether, in order to meet the distress caused by famine, the export of grain from India should not be restricted or stopped altogether. This question has been so fully and ably discussed by such authorities as Mr J. E. O'Conor, Sir Edward Buck, and Mr Holderness, that there is no call for me to say more than to emphasise the general conclusion come to that what is exported is practically the *overplus*, often specially grown for the purpose of export, and that if it did

Export of grain

The amount of wheat exported is at present only about one

per cent. of the total of the food grains produced, and only one-tenth of the total wheat crop.

Railways have, it is true, greatly facilitated export, but they have also done service in preventing fluctuation of prices in different parts, whilst their value, in time of famine, for conveying food to distressed districts can hardly be over-estimated.

CONCLUSIONS.

400. In this chapter I have touched on some few of those economical and political conditions which have an important bearing upon agriculture and on the possibility of its improvement. Many others there are, such as social habits, emigration, etc, but my purpose has been merely to introduce a few, lest I should be thought guilty of ignoring their influence on the progress of agriculture. I have, however, expressed my inability to discuss them properly, and, besides, they are such as do not strictly fall within the scope of my more special enquiry.

I therefore refrain from making any recommendations under this chapter.

CHAPTER XVI

CHAPTER XVI.

PRACTICAL AGRICULTURAL ENQUIRY.

PRACTICAL AGRICULTURAL ENQUIRY

401 The foregoing chapters consist of a review of the agricultural conditions of India, as they presented themselves to me during my tour As each subject has been successively dealt with, I have indicated where improvement may, in my opinion, be effected

In the concluding chapters of my Report it will be my object to discuss in detail the agency by which the suggested improvements may be carried out

Scope of the present chapter

I have had occasion, in almost every one of the sections, to point out the necessity which exists for a systematic enquiry into present agricultural practices, and to insist upon the acquirement of definite knowledge before attempts are made to *teach* any fresh system, or to carry out any extended work of experimental research

It is with this matter of practical enquiry into agricultural conditions and methods that I shall occupy myself in the present chapter.

Necessity of combining practice and science

402 Practical enquiry, or, as I may here put it, the obtaining of knowledge resp
tific enquiry and
ledge of the pract
ries in the right direction, and, however able his researches, he may fail from being unpractical Similarly, the experimenter, without a knowledge of what is done elsewhere, or of what is within the reach of the cultivator, may waste both time and money in trying what has no chance of ever becoming of any practical value

The practical man must first become thoroughly conversant with *what is being done in native agriculture, and with the conditions* under which it is carried on, then the scientist may come in and explain the *rationale* of the practice, and may apply these principles to the extension of the better systems, and to the discovery of further resources, finally, by the happy combination of *science and practice*, the work of experiment may proceed in a definite and useful direction In this way some advance in agriculture may be made

The scope of enquiry

403 As I said in my opening chapters, I believe that it will be possible here and there to graft on to Native practice the results of Western experience, but the main advance will come from an enquiry into native agriculture and from *the extension of the better indigenous* methods to parts where they are not known or employed.

In addition to the improvement of agricultural methods, there comes another most important branch wherein enquiry is absolutely necessary, this is the ascertaining of the requirements of different parts of the country in respect of facilities present in some, and deficient or absent in others To this class belong those physical surroundings which I have summarised in paragraph 18 (Chapter II), and which are comprised, mainly, in the supply of water, manure, wood, and grazing.

The necessity of enquiry recognised

404. It must be clear to every one that, before any improvement in the agriculture of a country can be effected, the first preliminary is that a knowledge of the country, its conditions and its needs, be obtained I may also say, without fear of contradiction, that, as regards India comparatively little is known of its agricultural methods and that they have only been so far, the subject of casual and isolated enquiry by individuals An organised system of enquiry, on the other hand, might result in the collation of definite knowledge of the agricultural resources and needs of the country

By the Famine Commissioners

The Famine Commission recognised the necessity of careful and organised enquiry in order to get a real knowledge of the agricultural state and conditions of India I repeat the quotations from their Report, already given in paragraph 15 —

> ' The defect in the efforts made by Government to instruct the cultivator " has consisted in the failure to recognise the fact that in order to improve ' Indian agriculture, it is necessary to be thoroughly acquainted with it

By the Government of India

This view was also entertained by the Government of India in their Resolution of December 1881, in which they strongly urged

"alike for its protection against famine and for the improvement of the agricultural system."

Sir J B Lyall's opinion

The Lieutenant Governor of the Punjab (Sir J B. Lyall), in a recent note says —

> ' I am altogether averse to attempts to give instruction in the practical ' business of agriculture . our positive and comparative knowledge of the " subject are alike insufficient to warrant such an attempt at the present time '

Mr J B Fuller's opinion.

In a Note prepared for the Agricultural Conference at Simla in October 1890, Mr J B Fuller writes —

> agriculture at our
> fore we can trace
> ome parts of India

Opinion of the Madras Government

The Note of the Madras Government presented to the same Conference says, in reference to the failure of experimental work in that Presidency —

> " The experiments . . were doomed to failure either from want of intrinsic suitability or from want of knowledge of indigenous practices and ' conditions . . the faults . . would not have occurred had there been a

"department of wide knowledge and full experience of native and, especially, "local practice and conditions.

The policy proposed by the Madras Government contains as its first recommendation, "the institution of a careful and definite system of enquiry into existing practices," and it mentions "the importance of enquiry as an essential preliminary to any original endeavours to improve Indian agriculture."

"Agricultural analysis" has been confined to the collection of statistics

405. The "agricultural analysis" proposed by the Government of India has, up to the present time, been confined to the collec- and of information regarding the *nd there has been no enquiry into* ew to agricultural improvement. ıbse-

purpose, and the want of money fo whilst "Land Records" have been cultural knowledge and improvement have remained much where they were when the Famine Commission issued their recommendations.

This was not the intention of the Government of India.

That it was not the intention of the Government of India to confine an "agricultural analysis" to the collection of statistics is shown by the following extracts from their Resolution of December 1881 —

"It is necessary to point out that the agricultural enquiry should not be "confined to the mere collection or collation of statistics, in the ordinary accept-

Again —

" ... will follow the gradual ... the ... an ... ced ... ent

Sir Edward Buck, in reviewing, in March 1890, the position *of the Department of Land Records and Agriculture, says* —

"The agricultural conditions have only been studied with the view of "getting general knowledge as to the liability of famine, but not as regards "agricultural practice, its advantages and the desirability of extension, its "deficiencies and possible remedies."

The field for enquiry

406. The above extracts show abundantly that the need of acquiring knowledge of agricultural practice is fully recognised as a preliminary to any scheme of agricultural improvement.

Before considering what agency is best able to deal with the work of enquiry, it will be well to set out in more detail some special points on which that agency might usefully occupy itself,

in addition to the general one of becoming acquainted with the systems of agriculture practised in different parts.

Firstly, it is important to ascertain the requirements of each district in regard to the provision of water, of manure, of wood, and of grazing, and to decide in what way the needs can best be met; whether, for instance irrigation by canal or by wells is best suited, whether embanking of land should be done, whether "Fuel and Fodder Reserves" can be [illegible] vided, whether the *taccavi* [illegible] provement is properly brou[illegible] them; and so on.

Secondly, it is desirable to ascertain where a transference of the practice of one part may be beneficially made to another part. Of this nature are, the embanking of land, green-manuring; hedg- [illegible] of night-soil and town-sweepings, the planting of sugar-cane in furrows, the use of the iron sugar-mill and shallow evaporating-pan in sugar manufacture; the extended growing of sugar-cane, potatoes, and other crops

Thirdly, there are a number of questions of a practical nature which await solution, and which, though mainly of the nature of experiment, cannot proceed without first employing practical enquiry. Such questions are What is the outturn of different crops? What is the right amount of seed to use in sowing rice? What quantity of water should be employed in rice cultivation? Does manuring of rice fields pay? Would draining of rice fields be advantageous? What is the relative outturn of sugar from different varieties of cane? Does continuous growing of sugar-cane pay? Will it pay in the long run to grow a long-stapled variety of cotton rather than the short-stapled varieties generally grown? Is interculture of other crops with cotton profitable? Is the use of bones advantageous?

Lastly, there are points more connected with the introduction [illegible] iple, the possibility of [illegible] varieties, the acclimati- [illegible] aking of silage, the use of new implements, the use of litter and preservation of urine, the better conservation of cattle manure, the reclamation of salty land (*usar*), of ravine and other waste land.

407. The enumerationof the subjects set out in the last paragraph clearly points to the necessity of having an agency of an expert nature to deal with them They are not matters which [illegible]

The need of an expert agency

Opinion of Famine Commissioners and Government of India.

I must here repeat the extract quotated in Chapter I, paragraph 4, from the Government of India's Resolution of December 1881, when commenting on the Famine Commissioners' Report —

"The Famine Commissioners have, with great distinctness, intimated "that . . . . a *permanent agency* should be closely associated with the existing authorities in each Province for the systematic prosecution of agri-"*cultural enquiry* The importance of this view, which directs attention to "those duties of the Agricultural Department which must precede any attempt "at agricultural *improvement*, has hitherto been *far too greatly overlooked*"

The Resolution also says —

"The desirability of closely associating the permanent agency thus required "with the existing administrative staff is throughout the Report of the Famine "Commissioners, strongly indicated. The system, they write, should be "worked by the ordinary official staff, supplemented, where necessary, to meet "the special circumstances of the case."

And later :—

"The Department having thus primarily turned its attention to those parts "of the country in which agriculture is depressed, or its results uncertain "may hereafter give consideration to the general improvement of agriculture. . It may, as time goes on, become the duty of the Department "*to associate with itself in this investigation the assistance of qualified "experts*

The Notes presented to the Agricultural Conference at Simla in October 1890, by the Government of India, the Bombay Government, the Madras Government, the Bengal Department of Land Records and Agriculture, the Poona Agricultural Association, and by Mr. J. B. Fuller, contain references to the need that exists for the *employment of agricultural experts*

Note of the Government of India, May 1890.

The Government of India's Note says —

"Continuous enquiry should be maintained by means of Experimental "Farms or other similar agency, with the view of ascertaining the possible "results which may be gained by the introduction of new, or the modification "*of existing, processes and practices connected with agriculture.*"

Note of Government of Bombay, 1890.

The Bombay Government point out that they have appointed a European expert as Superintendent of Farms, and have established agricultural branches of the Colleges at Poona and Baroda.

The Madras Government's Note says :—

Note of Madras Government, 1890.

"The experts . . . . . were chiefly occupied with farm and college duties, "and could not work continuously and closely at the numerous investigations suggested or thrust upon them from time to time, and which required the organised staff of a Department"

The second of the Madras Government recommendations (the first being the institution of a careful and definite system of enquiry into existing practices) was, "the inauguration of experiments under the control of *trained agriculturists*" And it was suggested that "a certain number of agricultural inspectors should be employed on a careful and minute study of agricultural practices, their work being carefully directed and supervised by *European experts*" In addition to having the present *Assistant Director of Agriculture*, it was resolved to apply to the Secretary of State for a second European *expert* to be *primarily employed in investigations into the methods of agriculture followed in the various parts of the*

Presidency, and to attach two of the agricultural inspectors to this officer.

Note of Bengal Department of Land Records and Agriculture, 1890

The Bengal Department of Land Records and Agriculture, which was only started in 1885, recognised at the outset the need of agricultural enquiry, and employed two or three of the Assistants in the Department who had made a study of agriculture in England, to enquire into the systems of a few of the most important districts in the Presidency. The Reports on the Agriculture of Dacca by Mr. Sen, and on that of Lohardaga by Mr. Basu were outcomes of this policy. The subsequent usefulness of the special officers was, however, greatly destroyed by their transference to other Departments, or their employment in purely office work.

Note of the Poona Agricultural Association, 1890

[illegible] cultural schools, and preferably belonging to the agricultural classes."

Mr Fuller's note, 1890

Lastly, Mr. J. B. Fuller, in his Note, says:—

"Much success . . . cannot be hoped for unless Agricultural Departments are officered by men who are not only trained in agricultural science, but also have an intimate acquaintance with Indian agriculture . . . Very little success can be expected unless a permanent *technical assistant* is attached to each Department."

408. From the time accordingly, when the improvement of agriculture was first seriously considered, until the present time, there has been a strong expression of opinion, in which I fully concur, that the work is one which requires a *permanent agency*, and the assistance of men possessed of the requisite *technical knowledge* Agriculture is a distinctly technical subject, and no one without a special training in it can be expected to deal successfully with it.

The present agency.

At present the only agency that exists is the Director of the Department of Land Records and Agriculture in each Province, together with his office staff The latter, with few exceptions, are men who have had no previous acquaintance with agriculture, either by their early training or by their surroundings, and their duties are mainly those of compiling Statistics and keeping Records In Bengal, as I noted just now, Assistants to the Director have been appointed from time to time for special agricultural work, but it has not been continuous in character, in the North-West Provinces, in Bombay, and in Madras, Assistant Directors of the Department have been appointed, but all of them have laboured under difficulties, and their principal duties have been those of office work, and not those of a strictly agricultural nature.

Coming next to the Dire [illegible] Records and Agriculture (for [illegible] cumbersome title, and not that [illegible]

is conveniently but erroneously called), it must be at once said that, with rare exceptions, he has not the necessary technical knowledge to fit him for the work of agricultural improvement The early training of the future Civil Servant is not one which directs his attention specially to, or encourages the pursuit of, Natural Science, but it is rather one of a classical, mathematical, or literary character. After the selection of men by open competition there is no special inducement given to them to study natural science. It is only within the last [illegible] as been introduced into [illegible] along with other branc [illegible] whose bent is towards those sciences, a knowledge of which would be useful to him later as an Agricultural Director, is at a disadvantage compared with the classic or mathematician. I am well aware of the difficulties which stand in the way of allowing probationers to study agriculture as a special subject before going out to India, and I do not advocate that this should be done, for there are other more important duties for which the Civil Servant has to undergo a special preparation at home. But I mention these matters for [illegible] the time of his landing in India, [illegible] future Agricultural Director [illegible] Judge, and that he arrives without having acquired any technical knowledge whatever of agriculture Not even after arrival in India is the case much better, for all alike pass through much the same course of district work. In this way a man acquires a certain amount of acquaintance with the agriculture of the part where he is placed, but it is mainly with the work of the court-house (*cutcherry*) that his time is occupied. Later on, administrative and magisterial duties have the first claim upon a Revenue officer, and, unless it should fall to his lot to be entrusted with the Settlement of a district, he hardly comes at all into close relations with the agricultural practices and conditions of the part where he happens to be An acquaintance with agriculture is, as a matter of fact, no necessary qualification for the [illegible] ure, nor would a man hesitate, [illegible] special knowledge of agricul- [illegible] were it offered to him So it comes about, and the past history of Agricultural Departments abundantly shows it, that the Directors are simply men of administrative ability, taken out of the regular Revenue line, for one reason or another, but *not* of necessity because they have shown [illegible]

[illegible] is know- [illegible] *icultural* [illegible] neglect. [illegible] varied ; there are Land Records to be kept up, and the work of inspection of village accountants (*patwaris*) to be done, so that, with these and the necessary office work, the Director has but little time to

give to the study of the details and systems of agricultural practice,
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Records, and *not to attempt* the larger one of agricultural improvement. Thus, in effect, the Director becomes what he is strictly defined as being, *viz.*, Director of the Department, rather than what the holder of such an office should be, *viz*, the Director, or, better still, the Commissioner of Agriculture The agriculture of the country can hardly be said to be capable of being *directed*, but the oversight of it in a Province may be *committed* to the care of an individual.

From having, therefore, his time fully occupied with administrative duties and with other work, but mainly from not having the technical knowledge which may fit him to deal with agricultural questions, the Director of the Department is, in most cases, obliged to leave the work of agricultural improvement alone It is significant to note that in January 1878, subsequent to the appointing of a Director of Agriculture and Commerce in the North-West Provinces, application was made to the Secretary of State for an Assistant to the Director, on the ground that "the "discharge of the duty devolving on the Director requires the posses "sion of qualifications which cannot be acquired without special "training"

It would not be right, however, were I to pass without acknowledgment the good work that has been done by some few members of the Covenanted Service who have held the position of Director of the Agricultural Department of their respective Provinces But, when I come to examine the individual cases to which I refer, I find that in every instance the success has been the outcome of an innate love for Natural Science, and more especially for those branches of it which are most closely allied to agriculture, or from their having already possessed some practical acquaintance with agriculture. Unless one or the other of these elements be present, I fear that success will seldom follow even well-intentioned efforts

A further hindrance to progress is met with in the frequent changes which take place in the occupancy of the Directorship A Director no sooner has got his staff into working order, and possibly has [illegible] or commenced some protective [illegible] s liable to be called away to fi[illegible] essor may have no sympathy [illegible] to lapse In this way the work of Agricultural Departments has largely been the result of spontaneous efforts of individuals rather than of one continuous system of enquiry maintained throughout Continuous enquiry cannot be carried on without a *regular agency* for the purpose, and so long as it is entrusted to men whose tenure of office has no element of permanency about it, the results will be disappointing. I might mention the reclamation experiments at Awa and at Jhansi (*see* paragraphs 70 and 75), as instances of enquiry begun but not concluded

kind alluded to. So also might it be at any time with respect to the ravine reclamation carried on at Etawah (*see* paragraph 70), the *usar* experiments in the North-West Provinces (*see* paragraph 75), and other similar work.

Agricultural experts

409. Technical knowledge of agriculture is, we have now seen, the missing element in the existing agency of the Departments of Land Records and Agriculture. I shall, therefore, proceed to consider how this lack of technical knowledge can be best supplied.

[illegible]

likely to work out some improvement in agriculture th[illegible] present organisation. [illegible]

I [illegible] this [illegible] whic[illegible] Undoubtedly men trained in agriculture, and [illegible] knowledge both of its science and its practice, would be [illegible] better qualified to deal with purely agricultural questions th[illegible] ordinary Civilian Director, just as it needs a geologist to dea[illegible] geological subjects, and a chemist with chemical ones [illegible] everything be reconstruct[illegible] tion in India be altered, [illegible] My work is to sug[illegible] [illegible] to be done, and it is n[illegible] for me to pr[illegible] carried out. [illegible] to sciences su[illegible] these sciences [illegible] be studied in [illegible] any direct re[illegible] the people of that district. An officer [illegible] the Geological Survey, for instance, may pursue his enquir[illegible] equally in the gold mines of Mysore, the ruby mines of Burm[illegible] the coal measures of Bengal, or the oil districts of Beluchist[illegible] He need be confined to no one locality, but may be drafted in succession to each, and thus have no particular head-quarters. Bu[illegible] whenever [illegible] once into [illegible] and main[illegible] All questions of agricultural improvement touch upon the circumstances both of the people and of the State, and it is impossible t[illegible] divorce the two. Wherever he goes, the agricultural enquirer, a[illegible] I know from my own short experience, will be brought face to fac[illegible]

with matters in which, not agricultural matters alone, but also the administration of Land Revenue is concerned The Famine Commission recognised that agricultural progress was bound up with considerations of a Revenue character, and for this reason they did not recommend the formation of an Agricultural Department administered by experts alone They hinted rather that it might be found necessary to associate with the Department the assistance of qualified experts This is the opinion which I hold, too, although I would more strongly press the *absolute need* of obtaining this expert knowledge without delay There are, as I have pointed out, duties other than those of being practical agriculturists which fall to the share of the Director of an Agricultural Department, and which could not be discharged by experts alone Besides this, unless the agricultural expert be in complete touch with the Revenue authorities, and unless he have placed at his disposal the services of the Revenue subordinates, his progress in the way of agricultural improvement is hardly likely to be facilitated, or his
is significecome an enviable one On the other hand if he proceeds
appointmork under the authority of the present Director and in
North-Wwith *the Revenue authorities of a district, he is likely to*
State foed with all facilities in making his enquiries. These may
"dischants of small importance to one unacquainted with India
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It *be* and my endeavour is, therefore, to graft improvements
ledgmeisting systems, rather than to suggest the subversion of the
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of the r giving much attention to this subject, I have come to the
when usion that the want of technical knowledge in the existing
find ty can best be supplied by the employment of *agricultural*
innat*ts*, such as were contemplated in the recommendations of the
branine Commissioners and of the Government of India, and
thereh are also indicated in the several notes presented to the Agri-
agrtural Conference at Simla, in October 1890
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If with the Director were associated one or more Assistants, who
chae trained experts in agriculture, and whose duties would be purely
Agricultural, the lack of technical knowledge in the Department
pould be supplied It would be necessary that these experts should
prt be hampered with the routine of office work, but be free to
awrsue, under the orders of the Director, the practical work of
syquiry With the help of such an Assistant or Assistants the
administrative ability of the Directorate would be supplemented by
that knowledge of a special character which is required to enable
it to deal with practical questions, as well as to carry on a continuous system of enquiry and, possibly, of experiment The regulative skill and administrative qualifications of the Director would still be employed in seeing that the time of the Assistant was being usefully employed, and both enquiry and experiment
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study of the requirements of a particular district and of its agri-cultural practices, to effect a transference of method from one part to another, or to introduce a new crop, or, perhaps, a new imp-ment, and to pursue the other enquiries which I have sketched out in the earlier part of this chapter (*see* paragraph 400)

In this way I believe that the Department might be made of really practical benefit to the cultivator, as well as a ... administrative branch of the Executive It must, however, be clearly understood that to carry this out efficiently an Ass... must be free to employ his whole time in this work, and to pass it among the people themselves; it would be inadvisable to have an enquiry conducted merely during the interval of leisure from office duties, for, an enquiry once begun, must be cont... through it. The men who are appointed must be those who would take up the study of agriculture as the business of their life, meaning to devote their whole attention to it. On ... the past has been that when Natives have been employed in agri-cultural work they have not been taken from the right class, nor have they had the training best fitted for them, so they have not regarded agriculture as their profession at all ... have waited for their chance of obtaining an appointment in some other branch, or of turning to the Law ... culture ought to be a distinct profession, and the man who enters it should prepare for it, intending to devote himself to it in just the same way as the Forest Officer enters the F... Department or the Engineer the Public Works Department, that is, with the intention of remaining attached to that ... Agriculture, on the contrary, has had no permanent ... carry on its work, and no staff of native subordinates who have been trained in it, or encouraged to continue in its pursuit.

Should agricultural experts be Europeans or Natives?

410. The question now forces itself upon consideration, ... the agricultural experts to be Europeans or Natives? ... attempting to lay down a rule to be followed in all cases, I would indicate my opinion that they should, by pref... be Natives, and Natives trained in India, not in England.

Frequent have been the attempts to provide the expert ... sessing agricultural knowledge, first, by sending home to England selected Civil Servants, to enable them to qualify ... study of agriculture at Cirencester or elsewhere, for the ... cultural Directorship on their return; then by sending ... who have graduated in the University, and allowing them to study agriculture in England, in the belief that on their ... they would make useful agricultural officers. But neither ... has worked well as a whole, though in the case of the ... Servants it must be said that they have fairly justified ... selection, and have shown the good results of the ... given to them. But the study of agriculture at a College ... not constitute a man a practical agriculturist, and unless ... instruction be followed by practical experience on a farm ... not complete. Again, a man has to learn Indian and not ... agriculture, and this cannot be taught at an institution

Cirencester College. There are further difficulties in the matter of furlough, and in the changes in tenure of the Director's office, which make it only occasionally desirable to equip a Civil Servant in the regular line with such special training in agriculture as would be obtained by a two years' residence at an Agricultural College in England On these grounds, and because of the duties of the office being also largely administrative, I do not think it generally feasible to have the Director himself an expert agriculturist

Some of the arguments advanced tell also against the employment of European expert assistants. They may have a knowledge of English agriculture, but if they begin to apply what they know, before they have studied the conditions of Indian agriculture, they will but repeat some of the many blunders which have made people in India doubt the possibility of improving Indian agriculture at all through the agency of English experts It is true that in most cases the right men have not been sent out, and that the first lot of agriculturists (so-called) were nothing more than gardeners, and unacquainted with agriculture But, whether from this cause or from others, a disbelief in the expert has, anyhow, been begotten Other men of a very different stamp, such as Mr Robertson and Mr Benson, have been brought to Madras, and have laboured there under circumstances of, it must be said, a very discouraging nature, for they have received neither the sympathy nor support of their Government, and have been the victims of a continual change of policy on the part of that Government Duties of office work, or of a tutorial nature, have prevented them from devoting themselves to strictly agricultural work, whilst a zeal on their part to introduce new implements and new methods has not been always moderated with the necessary caution in applying English to Indian agriculture An Agricultural Department, the Director of which is purely a Revenue man, and who does not spend a certain portion of each year in camping about in his Province, is hardly likely to be in full sympathy with efforts made to improve the agriculture, and so it has proved to be the case in Madras Now, at length, the conclusion is arrived at that it is first necessary to learn more about the methods of Indian Agriculture, and the Madras Agricultural Committee of 1890 have recommended the employment of experts to engage in the work of direct enquiry

The chief points gained in selecting Natives as experts instead of Europeans are, firstly, that they start with great initial advantages in knowing the language, the habits of the people, and (if they be wisely selected) the conditions of agriculture and the methods employed, secondly, that the selection of Natives would be very [illegible]

[illegible]

may be desirable to have one European expert Assistant to the Director, but this will be guided much by financial considerations.

and, if only the proper training be provided, I consider that the work may be done quite well by Natives. If a European be selected he should be a man who has gone through an agricultural course of training, such as is provided at Cirencester, Downton, or other Agricultural College, but supplemented (and on this I would insist) by practical experience on a farm. In the matter of salary the procedure adopted by the Forest Department with the men who pass out of Cooper's Hill College and who go in the Forest Service might be followed, a similar rate of pay and increase, according to time of service, being given.

Where should they be trained?

It is, however, in the end, to the Natives that we must look to carry out the work of agricultural enquiry, and it becomes, therefore, important to consider how a training in agriculture may be imparted to them. This subject will occupy a subsequent chapter in my Report. Suffice it to say here that I am distinctly in favour of giving an agricultural education in India,

Training in India preferable

rather than of sending Natives to England to study. Past experience has shown that the men selected for a European training have not been those whose associations and interests have been with the land, but they have been men of literary inclinations, who have graduated with distinction at the Universities. Their sharp intellect and wonderful facility in picking up any subject to which they devote themselves have made them apt students of the literature rather than of the practice of English agriculture, and in most cases they have tacked on a study of Law to that of the subject to acquire which they were sent over to England at Government expense. On their return to their country they no longer live as they used to, but adopt European ways and costume, more or less, and become *generally discontented with the position* which they occupy. In short, the residence in England has had the effect of spoiling them for occupying the position in the Agricultural Department for which they were intended to qualify, and they take the first opportunity they see of becoming "pleaders" in the Courts. In this way the expensive education given to Natives sent home to England is, as a rule lost to the Agricultural Department, while those who still remain connected with it are dissatis-

Should agricultural experts be Europeans or Natives?

with their position and prospects

sessing these grounds, therefore, *I strongly advocate a training*
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who have vary in different Provinces, and according to the work to
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they would eventually be found useful. As the essence of success
has worked the acquirement of local knowledge, the Assistants
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given to them here that care should be taken in the selection of
not constitute a hoose as far as possible, men from the agricul-
the foll such as have an interest in the land, and who
ricultural surroundings. Too often men have
ranks of those who, as a rule, follow the

profession of the Law, and who do not regard the pursuit of Agriculture as in any way a profession.

411. I have now discussed in considerable detail the question [illegible] rts, and would conclude by [illegible] views (subsequently only [illegible] Conference at Simla, in October 1890, they received a very general approval, expressed in the terms of the two following Resolutions passed at the Conference — Views of the Agricultural Conference at Simla, 1890.

First.—"That, in the opinion of this Conference, it is essential, [illegible] "Assistant or Assistants who are experts in the practice and theory "of agriculture."

Second —"That it will be preferable to train Natives to be "qualified for the post of Assistant in the Agricultural Department "in this country rather than in Europe, and that this end cannot be "attained unless there be a high-class education established in this "country."

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RECOMMENDATIONS

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413 That a definite system of organised Enquiry into agricultural conditions and practices be instituted forthwith.

That a Permanent Agency be established for this purpose, and consist of the association with the Director of the Department of Land Records and Agriculture of an Assistant or Assistants who are trained experts in agriculture

That such experts be, by preference, Natives of India, and be trained in the country itself

That high class Agricultural Education be provided in India so as to train the men who are to become agricultural experts

CHAPTER XVII

SCIENTIFIC AGRICULTURAL ENQUIRY

CHAPTER XVII.

SCIENTIFIC AGRICULTURAL ENQUIRY

The connection of science with practice

414. The important services which science has rendered to agriculture are now universally recognised, and the marked development of agricultural knowledge during the last half century is the direct outcome of the application of science to practice

It is the domain of science to explain the principles which underlie good practice, and to extend the application of these principles, as well as to make fresh discoveries that may be of benefit to agriculture The work of improvement, had it proceeded simply from the practical side, would have been, as it has always been, slow; but when science set to work to find out the causes of well-ascertained facts in practical agriculture, progress at once became rapid.

The application of science to practice may be briefly described as "the accurate knowledge of facts and the discovery of their "causes." When the underlying principles have been discovered, science can apply these to further developments of practice, and to new discoveries I might briefly illustrate the importance of scientific investigation in regard to practical agriculture by referring to the difference between the state of our knowledge at the present time and that which existed prior to the introduction of scientific enquiry.

The results of combining science and practice

Formerly, it was enough to know empirically that certain practices were good, that certain kinds of soil were suited to particular crops, that certain foods were useful for cattle, but no one could say more than that these things *were* so, and not *why* they were so. Now, however, the connection between soil, air, plant, and animal has been worked out, and our knowledge is being continually added to, we know, in great measure what plants are composed of, whence they draw their nourishment and in what forms it must be supplied to them, what the constituents of food are, and the changes which they undergo in the animal economy We are enabled thus to provide for the needs of field crops by suitable manuring, to repair the demands made upon the soil to feed stock on a rational system, and to cultivate the land on other than stereotyped lines. Distant countries have been put under contribution to supply manurial resources for our crops and food for our stock. In short, a definite knowledge of the processes taking part in the practice of agriculture has been obtained through the medium of scientific enquiry. At the present time an enquiry is going on which is of the highest importance to practical agriculture. I refer to the possible assimilation of the nitrogen of the atmosphere by certain plants. The establishment of this theory will go a long way to explain much that has so far not been understood in agricultural practice, and may also have important bearing upon the practice of the future

Practical enquiry will always be needed to keep up the knowledge of what is being done, and to provide a field for scientific enquiry, but it is, nevertheless, from the latter that, wherever it is possible for development to take place, any great future advance will be made

415 The above remarks have been made in reference to agriculture in general, and not to Indian agriculture in particular I have shown, indeed, in earlier chapters, that the conditions of agriculture in India are such as to greatly limit the possible scope for improvement, and, consequently, to narrow the field for the application of scientific enquiry. As Mr Thiselton Dyer points ... shows it to ... landowners ...ovement by ...alth to carry it through, but the poorer tenant farmers would never have *initiated* such enquiry, although they were not slow to adopt its results when they saw that it *paid* The non existence in India of any class corresponding to the resident English landowner of intelligence and wealth is a bar to the progress of original agricultural investigation, and will limit the pursuit of enquiry to such matters as seem to have a direct bearing upon the immediate well-being of the people Further, the smallness of the holdings, the paucity of capital, the habits and prejudices of the people, and the financial obligations of the Government, are bound to impose obstacles which would not present themselves to such a degree in other countries. The special conditions of India limit the field of scientific enquiry

416 Nevertheless, adopting even this restricted view of the possibility of applying the results of scientific enquiry to agriculture, there are abundant reasons for its not being neglected altogether, and for advocating its pursuit whenever practicable Scientific method in enquiry necessary

Primarily, let me say that, if practical enquiry is to be successful, it must be scientific in its methods, it must proceed on a well regulated plan, and its results must be submitted to careful and critical examination. The mere collection and record of facts is not enough, they must be put into a connected and useful form, and they must be verified by experiment Such work as this cannot be adequately performed without the possession of a scientific training of mind by those to whom it is entrusted So far as India is concerned, I regard the proper regulation of practical enquiry, and the examination of its results, as one of the most useful ways in which scientific knowledge may be applied to the practice of agriculture

417 While acknowledging the bearing of sciences such as Botany, Geology, Physiology, Engineering, and Meteorology upon agriculture, it is Chemistry more than any other that has been productive of the greatest results to agriculture in the past, and from which, as coming most in contact with agriculture, the greatest benefit may be expected in the future The relation of chemistry to agriculture

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Practical enquiry will always be needed to keep up the knowledge of what is being done, and to provide a field for scientific enquiry; but it is, nevertheless, from the latter that, wherever it is possible for development to take place, any great future advance will be made.

The special conditions of India limit the field of scientific enquiry

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Scientific method in enquiry necessary.

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The relation of chemistry to agriculture

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Moreover, it is with the application of chemistry to the improvement of Indian agriculture that the present Report is largely concerned.

Such rapid strides, however, has the science of chemistry made within recent years, and so widely has it ramified into almost all branches of industrial occupation, that agricultural chemistry, or the application of chemistry to agriculture, has become a branch by itself, involving separate and special study. It will be my business, in the remarks that follow, to see how agricultural chemistry may be most usefully brought to bear upon the improvement of agriculture in India.

Opinions as to the desirability

418. The need of bringing in the aid of agricultural chemistry

the Geological Survey, writing in 1877 upon the "Reh" enquiry, said —

Government of India 1881

The need of an agricultural chemist was foreseen by the Government of India in 1881. In their *Resolution of December 1881* they said .—

"Finally, the science of agricultural chemistry will be demanded for the solution of many important agricultural problems"

Government of India 1881

In 1883 the Government of India formed a strong opinion that there should be an agricultural chemist for the Northern Provinces, and mentioned the vast unculturable tracts that existed on account of the occurrence of soda salts which impregnated the soil. They considered that the aid of science might reclaim these lands Consequently in their Despatch of 8th February 1883, they asked the Secretary of State to sanction the appointment of an agricultural chemist who could be used for this work and for educational purposes as well. It was proposed to establish an Agricultural College in the North-West Provinces, and to attach an agricultural chemist to it. The Secretary of State refused the application on the ground that the matter was a provincial and not an imperial one

Government of India 1884 1886 1889

Successive recommendations for the appointment of an agricultural chemist have been made by ment in 1882, 1884, 1886, and supported by the Government of however, while allowing the importance of the matter, has expressed himself as not satisfied with the methods proposed

Agricultural Conference October, 1888

n October enormous s) wanted

to be answered, and which only a chemist could answer . . .
" . . . was needed for
" England found
" was needed for
"investigation, and as a referee, quite apart from the question of
"education."

Sir Edward Buck, in conversation with me, succinctly stated his opinion that all attempts at agricultural improvement must have for their basis some scientific groundwork, and as chemistry is the science that comes most in contact with agriculture, he considered that an agricultural chemist, to act as an agricultural expert, is the man most needed and most important. Sir Edward Buck 1890

419. In the preceding chapters I have, when dealing with each subject in detail, taken occasion to point out where the assistance of an agricultural chemist could be usefully employed. I have instanced several matte . . . investigation because of the . . . Scope for work an agricultural chemist.

. . . e possible exhaustion of . . . and the export system, the sufficiencies and deficiencies of different soils in respect of the various soil constituents, the nature of alluvium and black cotton- . . . int of . . . en by . . . their . . . , and . . . water . . . water, the composition and use of different manurial substances, and their . . . e discovery of fresh manurial . . . cattle manure, the explanation . . . ion of food products, and the relative values of different fodders, the nature of native clarified butter (*ghi*) and other dairy products, the causes which affect the out-turn of sugar, the investigation of the chemical changes which take place in the manufacture of indigo, and the parts they respectively play in influencing the produce, the examination of suggested improvements in indigo manufacture, the influence of manuring upon the cultivation of tea, the investigation of the processes employed in the manufacture of tea, the manurial treatment of coffee, the curing of tobacco. Scientific investigation

420 But there are other duties which an agricultural chemist would be called upon to discharge, and these, while somewhat of a different nature to the above more independent and scientific investigations, are of great economical importance in the progress of agricultural enquiry and experiment. I allude chiefly to the work of planning, regulating, and watching practical enquiry and experiment, and of critically examining and systematically recording the results obtained. My own experience has Association of chemist with practical enquiry and experiment.

See footnote page 27.

abundantly shown me that, though the undertaking of a practical enquiry or of an experiment in practical farming may appear at first sight a simple enough matter, it is the general fate of all such efforts to fail, or to fall short of the full benefit they might confer, whenever there is an absence of scientific design, supervision, and examination. I do not say that it is necessarily an agricultural chemist that is required, for, indeed, a man who is purely a "laboratory man" or, in other words, nothing but a skilful analyst, but who has not also an acquaintance with the details and requirements of agricultural practice, will not be at all a suitable person to select. But it is rather the man of a scientific turn of mind, and able to appreciate where science can be usefully applied to practice, who will be best fitted for undertaking the work of enquiry. It will not be long, too, I think, before he finds that he has to call in the assistance of more specially chemical experience to aid him. If, then, in one person [illegible] chemical [illegible] the [illegible] "pr[illegible] [illegible] have failed because the plan was not devised so as to lead to any definite or satisfactory conclusion, or because there was not that critical examination of the results which would enable a right conclusion to be drawn In these details of practical enquiry and experiment the assistance of an agricultural chemist would be of undoubted service.

Illustrated by *usar* enquiry

I have in an earlier page referred to the experiments on reclamation of salty land (*usar*). and [illegible] lief that chemical science [illegible]. It should have b[illegible] [illegible] in question was " [illegible] to what extent it was "salty," to what depth the saltness extended, to what particular salts it was due, what the surface water was, and what the subsoil water. Then, again, to what extent the various reclamation processes respectively succeeded in removing the injurious salts, what quantities of the salts proved harmful, and at what point the reclamation might be considered effected, whether the various salts were equally injurious or not.

Enquiry into canal and well waters

Again, I [illegible] of canal wa[illegible] speculating [illegible] the temperature of either water was, or whether one contained abundant lime, and the other not, when there existed for him ready means of absolutely determining the questions raised.

Methods of butter-making.

To take yet another instance, in Chapter XI, paragraph 264, I spoke of the competitive trials instituted, at the time of Mr. Howman's visit, between Native and European methods of butter-making. That the Native manipulators succeeded in obtaining a larger weight of butter from the milk given to them showed no more than their cleverness in incorporating with their butter a great deal of water, while Mr. Howman's butter was free from any excessive quantity It also left undetermined whether all the native-made butter was pure butter, or had some

amount of curd with it These are points where the help of the chemist must be brought in, and which can only be satisfactorily decided with his co operation

Experiments on Government Farms

Many have been the experiments carried out at Government Farms and elsewhere on the use of different manures, but, though to the practical man it may be enough to determine, possibly, whether this particular material is better than that, the chemist would not be satisfied with the limited results from such enquiry, results, too, which would have to be repeated each time anew as a fresh material came before his notice If, however, he can get at the principle or *rationale* of manuring, and can ascertain *what* it is in each material that produces the result, then the chemist can apply the knowledge he has gained to the utilisation of other materials containing like properties

The association of a scientific adviser with experimental enquiry would, without question, result in restricting both experiment and expenditure to more useful ends than has altogether been the case in the past

Examination of results of enquiries

It is very desirable, also, that the information to be conveyed by practical experiment should be set out systematically in a form in which it may be intelligible and useful The bare record of what has taken place, the harvest results merely stated *en masse*, or, what is perhaps even worse, the drawing of conclusions from each experiment without relation to what has gone before, are only likely to lead to the accumulation of tables and literature which no one will attempt to wade through A single experiment conducted simultaneously at four or five different places, and under varying conditions, is likely to lead to the acquirement of more solid knowledge than is the attempt to collate some 30 or 40 results at one experimental spot It needs, therefore, someone who shall adopt a scientific and critical method, and be able to look beneath facts to the principles that underlie them

The need of continuity in experiment

421 Perhaps one of the chief needs of agricultural experimental enquiry is to have someone associated with the enquiry whose recognised duty it shall be to *preserve the continuity* of experiment. How often could it be said of agricultural experiments in India that they had failed simply because there was no one whose *duty* it was to look after them, to see that they were maintained, that the results were duly recorded, and that they were made available for use! How many have been the men, who, eager to do something towards agricultural improvement, have begun this work or the other, and then have been transferred to some other district or Province, leaving their task to a successor who in all likelihood has not had the least interest in it, and so has let it drop altogether! This is the general fate of agricultural enquiry in India, and it will always be so until a *continuous and responsible agency* is substituted for the present system of spontaneous and amateur effort In this way the Awa experiments on *usar* reclamation (*see* paragraph 75) failed, and such might be at any time the history of every work of experimental enquiry or every Experimental Farm. Good

work has been begun, but no one has been charged with the oversight of it, it has been always a matter of personal choice and inclination, and what has been no one's duty, has, after a time, too often been neglected and lost sight of An agricultural chemist of the type I have suggested might, on the contrary, be definitely charged with the duty of maintaining the continuity of experiment, of watching its progress, of suggesting its development, and of examining and collating its results in useful form In some such way alone can experiment be carried to a successful termination, and the work is one which might well be conducted by a man possessing a fair practical knowledge of agriculture combined with a more special one of chemical science and scientific methods.

In the course of my tour I went to see an experiment on the reclamation of ravine land by means of embanking (*bunding*)* it, so as to hold up the water, and thus provide water and irrigation Wells were hard to dig, the water level being low and the ground rocky One object of the enquiry was to see if the water-level of the country would be raised by the embanking of the land On enquiring whether any rise had resulted, I found that it was impossible to tell, for, either the level at starting had not been taken, or, if taken, it had not been recorded, at all events, no one at the Station knew about it This does not require a chemist, it is true, but it is an instance of what will happen over and over again in India unless work of enquiry be entrusted to men of a scientific turn of mind, and also be put in the hands of a *continuous* and *responsible* agency, and not be left to amateur and spontaneous efforts

The need of a *referee or scientific adviser*

422 Another function which an agricultural chemist of standing could usefully serve would be that of acting as a "referee" or "Government adviser" in chemico agricultural matters There ought certainly to be someone in India who would be able to give an authoritative opinion on points where the relation of chemistry to agriculture is concerned. The advantage to [illegible] ght confidently [illegible] involving, as [illegible] eeds no demonstration Nor, again, is it necessary to explain how very useful such an adviser would be to the Agricultural Directors of the different Provinces Without having the power of interfering in *any scheme initiated by* [illegible]" would be available if the [illegible] in commencing, conduct [illegible] of any experimental enquiry.

Chemical knowledge of food products etc

Associated with such an office would be the duty of adding to chemical knowledge respecting the food products, crops, and other resources of the country, a work which has, so far, been but very imperfectly done

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* *See* footnote page 31.

423. Lastly comes the [illegible] in connection with the dev[illegible] Though not proposing, as I [illegible] suggested "scientific adviser" should be himself directly charged with the work of teaching at any fixed centre or centres, I nevertheless consider it very desirable that he should supervise such instruction as is given, and be responsible for its proper conduct. Let me say at once that, while I hold the teaching of Agricultural Chemistry as a special branch of science to be a desirable part of a general scheme of Agricultural Education, I by no means wish it to be regarded as indispensable for agricultural improvement under the conditions that exist in India. That there should be someone who has a good and practical knowledge of Agricultural Chemistry I certainly consider a necessity; but I do not imply that it will be necessary to spread instruction in that particular branch of science in order to achieve any success. The mere teaching of Agricultural Chemistry will not in itself create agricultural prosperity, though it may open the mind, and lead to an understanding of the principles upon which practice is based. In its methods it is explanatory and regulative rather than creative. In India there [illegible] case, having had experience as an examiner of Indian students who have come over to study agriculture at Cirencester and elsewhere. With wonderful powers of getting up any subject to which they apply themselves, and with marvellously retentive memories, they are able, by their accurate replies to the questions set them in an examination, to acquit themselves with credit and distinction; nevertheless, to an examiner who has them before him for *vivâ voce* examination, it is apparent that there is not that practical understanding of the subject, and that grasp of it, which are likely to lead to future benefit as the result of the study. The knowledge which these Indian students possess presents itself to me as that of a subject studiously and carefully got up with the aid of great natural abilities, but which remains merely as an impress on the mind for a time, and which fails when the call comes for its application to practice. Therefore, I do not look for great results to follow at once the introduction of the teaching of Agricultural Chemistry, and I would not suggest that provision be made for it on any large scale at first. Still, I think that there should be one or two places, perhaps, where instruction in Agricultural Chemistry could be given, both theoretical and practical. For the right conduct and efficiency of such teaching, and for its development when called for, the "scientific adviser" should be responsible.

The teaching of agricultural chemistry

In another branch of educational work the "scientific adviser" could render useful service. This is in the preparation of a text-book or text-books on Agricultural Chemistry, which shall be specially adapted to the case of India. At present there is no such book existent, and though it is true that the principles of a

Preparation of text books

work has been begun, but no one has been charged with the oversight of it; it has been always a matter of personal choice and inclination, and what has been no one's duty, has, after a time, too often been neglected and lost sight of. An agricultural chemist of the type I have suggested might, on the contrary, be definitely charged with the duty of maintaining the continuity of experiment, of watching its progress, of suggesting its development, and of examining and collating its results in useful form. In some such way alone can experiment be carried to a successful termination, and the work is one which might well be conducted by a man possessing a fair practical knowledge of agriculture combined with a more special one of chemical science and scientific methods.

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The need of a "referee" or scientific adviser.

422. Another function which an agricultural chemist of standing could usefully serve would be that of acting as a "referee" or "Government adviser" in chemico-agricultural matters. There ought certainly to be someone in India who would be able to give an authoritative opinion on points where the relation of chemistry to agriculture is concerned. The advantage to Government of having someone to whom they might confidently turn for guidance in chemico-agricultural matters, involving, as they often do, very considerable expenditure, needs no demonstration. Nor, again, is it necessary to explain how very [illegible] Directors of the [illegible] of any experimental enquiry.

Chemical knowledge of food products, etc.

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* *See footnote page 31.*

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* See footnote page 31.

423. Lastly comes the need of having an agricultural chemist in connection with the development of Agricultural Education. Though not proposing, as I shall presently show, that the suggested "scientific adviser" should be himself directly charged with the work of teaching at any fixed centre or centres, I nevertheless consider it very desirable that he should supervise such instruction as is given, and be responsible for its proper conduct. Let me say at once that, while I hold the teaching of Agricultural Chemistry as a special branch of science to be a desirable part of a general scheme of Agricultural Education, I by no means wish it to be regarded as indispensable for agricultural improvement under the conditions that exist in India. That there should be someone who has a good and practical knowledge of Agricultural Chemistry I certainly consider a necessity, but I do not imply that it will be [illegible] branch of science [illegible] of Agricultural [illegible] sperity, though it may open the mind, and lead to an understanding of the principles upon which practice is based. In its methods it is explanatory and regulative rather than creative. In India there is great fear that if Agricultural Chemistry be taught as a necessary part of an agricultural curriculum it will be studied in a purely *academical* manner, as an additional subject of a Course. I have had opportunities in England of judging how this is likely to be the case, having had experience as an examiner of Indian students who have come over to study [illegible] With wonderful powers [illegible] apply themselves, and [illegible] they are able, by their [illegible] in an exan [illegible] neverthele [illegible] examinati [illegible] standing [illegible]

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An agricultural chemist in connection with educational work

The teaching of agricultural chemistry

In another branch of educational work the "scientific adviser" could render useful service. This is in the preparation of a text-book or text-books on Agricultural Chemistry, which shall be specially adapted to the case of India. At present there is no such book existent, and though it is true that the principles of a

423 Lastly comes the … aring on Agriculture as actually practised
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certainly is … As one of the delegates to the Agricultural Conference
neces… Simla, in October 1890, said, "We want . . . a man who
in order … at once a good chemist in the laboratory and acquainted
Chem… with practical farming on its scientific side," this, it seems
it … to me, fairly describes the kind of man who is wanted. He must
pr… be a man of business habits and capacity, and also sufficiently
ex… practical to be able to supervise experiments, and to go round and
is … see what subordinate officers are doing, whether by way of
s… experiment, enquiry, or teaching

426 The next question that arises is, whether one such man is sufficient, or whether several are required. I am decidedly of opinion that, at the outset, *only one* agricultural chemist is wanted inasmuch as the scheme must be regarded as more or less experimental As I have pointed out already, I do not regard the want of an agricultural chemi… of agricultural improvement, alt… be a very necessary part of the the work of improvement Therefore, I would prefer to begin in a moderate way and not to commit Government to more than a tentative scheme, the further development of which would depend upon the success achieved by the initial one I do not deny that the suggested scheme is inadequate to meet the requirements of the country and of the different Provincial Governments, but it is all that, under present conditions, I feel justified in recommending, *viz*, the appointment of one first-class man to act as Government referee and adviser. For a complete scheme it would be desirable, I think to have an agricultural chemist in each Province, or, at least, in each of the three Presidencies, Bengal, Bombay, and Madras But it would be better to begin with one man, and if the necessity arose, and the desirability of … If one man, … mperial, but … ny Provincial Government which might wish to avail itself of his services would be entitled to do so, and, thus, his functions would be rather national than imperial The number of such men required

Necessity for extended time and opportunity of study to be given to a scientific adviser

427. The third point upon which I would insist is, that if any appointment be made, there must be sufficient time allowed to see whether the experiment (for such I must term it) be a success or not, also the man so appointed must have time and opportunity given him for acquainting himself with the methods and conditions of Indian agriculture A man, be he ever so good an agricultural chemist, or be his acquaintance with English agriculture ever so great, is almost sure to fail unless he have given him the opportunity of studying the peculiar surroundings of Indian agriculture In fact, he will almost have to forget, for the time, what he knows, and start afresh as a *learner*. To attempt to teach or to improve agriculture without first becoming acquainted with its conditions is to court almost certain failure I am only too well aware that whatever I have been able to gather during my own tour has been the outcome of those facilities which were so readily placed at my disposal, and of which I availed myself with the view of acquiring as much knowledge as possible of the agriculture practised in different parts of the country But, while the new comer will do well to regard himself for some time as a *learner*, it is equally incumbent it was-
to whom the giving of such an appointment is entr not been
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thence without going about and acquainting themse ultural
country, have proved of but small value The real bla who
attaches not to them so much as to those who have re
them to "make bricks without straw," and have also
write Reports, conduct experiments, and, in short, to es
appointment, long before they have had an opportunity s
ing themselves with the knowledge necessary for th to
charge of the duties which have fallen to their sha
putting this very strongly, but I am well aware of

which he shall remain in communication Suppose him to be engaged in an enquiry upon salty land (*usar*) reclamation, he may have samples of soil, or of water, or of salts, to analyse in pursuit of the investigation These cannot be analysed on the spot, but would have to be referred to a laboratory, and be done either by him upon his return, or, in the meantime, by some one working under his instructions This leads me to consider the desirability of having a second man as assistant to the "scientific adviser." This I would recommend on two main grounds, firstly, the advantage of having a resident analyst to carry out the details of work conducted in a laboratory, secondly, the advantage of being able in this way to provide for the teaching of agricultural chemistry at certain fixed places

In the work of investigation and enquiry there will be numerous analyses to be performed, and purely analytical details to be carried out, all involving care, skill, and special chemical training, but yet more or less routine in nature. It is not necessary, nor even desirable, that the time of a highly paid officer of special qualifications should be taken up with routine matters more than can be helped, but it should be devoted more particularly to that which he alone can do It is also very desirable that analytical work connected with any enquiry should proceed without interruption, under a fully qualified chemist, although circumstances might require the presence of the head man at a distance from his laboratory Were all analytical work of this nature to be left until the head man could return, and then had he to carry out all the analytical work with his own hands, there would soon be an accumulation which it would be hard, and often impossible, to overtake, and he would often be prevented, too, from taking up other work that calls for his special employment If, on the other hand, there were a second man, or Assistant Chemist, as I may best term him, acting under the directions of the "scientific adviser," he would be able to carry out all the analytical details, and present them to the senior chemist for his utilisation on his return, or for forwarding to him if still away Further the presence of an assistant chemist resident where the laboratory is, would ensure someone being on the spot, ready to attend to any analytical work required by Agricultural Directors, or for Experimental Farms, or to transmit anything for reference to the senior chemist A constant communication would thus be maintained between the "scientific adviser," and the laboratory where his work is conducted, as well as with those who might wish to apply to him

The utilisation of an assistant chemist for educational purposes

But the second advantage to be gained by the appointment of an Assistant Chemist is also a very important one, inasmuch as it appears to me to provide for the educational want which the Government of India represented to the Secretary of State and it at the same time meets the very proper objections of those who urged that an agricultural chemist should be used for purposes of investigation, and not directly for teaching With an assistant chemist resident at some centre where a laboratory is placed, the

teaching of Agricultural Chemistry at that centre might perfectly well be provided for. The assistant chemist, while engaged in his laboratory duties during part of the day, would be quite well able to give lectures on Agricultural Chemistry to students, and, from time to time, to conduct a class in practical laboratory work. The need that has been felt of late of providing a higher class of instruction for Native Forest subordinates emphasises the desirability of giving, in some such way as I have suggested, a training in Agricultural Chemistry as part of their Course

An assistant chemist to officiate in the absence of the scientific adviser

A third advantage would follow such an appointment. The changes, the leave takings, etc, necessitated by a residence in India, oblige the provision of a substitute to take the place of an absent officer Should this be the case with the senior man, it would certainly be an advantage to have an assistant chemist who, while working under the senior man, would be able to take his place in his absence, and thus not allow his work to be at a standstill It may be necessary, perhaps, at some future time to fill a vacancy in the higher office, and it might be found better to promote the junior man to the senior post and utilise the knowledge of India which he has already gained, rather than to make a quite fresh appointment, and to bring over a new man who would first have to go about and learn the agricultural conditions for himself, as his predecessor had done.

The qualifications of an assistant chemist

430 The qualifications of an assistant chemist must primarily be —

1stly. That he be a competent Analytical Chemist.

2ndly. That he possess aptitude for teaching, a good general knowledge of science and sufficient special knowledge of Agricultural Chemistry to enable him to impart instruction in it.

The location of a laboratory

431 It must now be considered where the laboratory and the assistant chemist are to be located It is naturally desirable that special work, such as is here involved, should be carried on under as favourable conditions in regard to climate and situation as is possible But, at the same time, a laboratory should not be so isolated as to fail to be of benefit to India as a whole As the "scientific adviser" is to be imperial, this might be a reason for his being attached to the Government of India, and for changing his *locale* when they do, so that he might be available when his advice was needed But, though it may be desirable to have the "scientific adviser" in touch with Government, I would rather see him peripatetic in character, and have him go about the country wherever and whenever required. Besides, neither Calcutta nor Simla appear to me altogether desirable places at which to establish a laboratory, certainly not for a whole year. Calcutta is quite at one corner of India, and, in regard to climate, is not suitable all the year round, while Simla is also too far removed from the rest of India, and is not likely to form a good educational centre. I confess my own predilections for choosing,

were it possible, some place which, while being agreeable on the whole, as regards climate, might be as central as possible, and hence available for the different parts and Provinces of India, Jubbulpore, for instance, is such a place, and had there been any suitable institution available there, I might have recommended its adoption as the location of the laboratory, and as the head-quarters of the "scientific adviser" and his assistant chemist Students from all parts of India would readily be able to come to such a centre, whilst it would have further advantages in enabling "the scientific adviser" to make it a good starting point for his various journeys to different parts, whether north, south, east, or west But I am not prepared at this stage to advise the building of any institution specially for this purpose, but, as the whole scheme is an experimental one, I think that it would be better to utilise those facilities which already exist, and to provide, as far as possible, for the development of scientific education at places where it has already obtained some foothold Agricultural Colleges are represented principally by the institutions at Saidapet (Madras) and the College of Science at Poona (Bombay), to omit the more recently established one in the Native State of Baroda. In addition to these institutions at which instruction in Agriculture is given, there is the Forest School at Dehra (North-West Provinces). The training of Forest Students is also carried on at Poona, students coming here from Madras and Southern India generally, whilst Dehra is intended to serve the purposes of Northern India It was in connection with the development of the Forest School at Dehra that the application first came for the appointment of an agricultural chemist for India, and, though I do not see my way to recommend the appointment of a special officer for that purpose, I certainly see a decided advantage in having a laboratory or laboratories placed where they may be utilised by Forest Students, and where their presence will include also the services of a man capable of imparting instruction in Agricultural Chemistry At Dehra there is already a very fair laboratory, which might quite well be adapted to the new requirements, this would serve for the North of India At Poona there is a very good laboratory also, [illegible] agriculture of the Deccan, [illegible] eing a pleasant place during [illegible] that were made when the [illegible] s first suggested, it was [illegible] to send its students to [illegible] Poona might serve for Bombay and the whole of Southern India After careful consideration, I think that the best plan would be to have the head-quarters and laboratory fixed for six months of the year at Dehra, and for the other six months at Poona In this way the need of imparting instruction in Agricultural Chemistry would be met for both Northern and Southern India, and, at the same time, the work of investigation would be able to proceed under fair climatic surroundings The Forest Students, both of Northern and Southern India, would be able to receive instruction, as well

Dehra and Poona the most suitable places

as the Agricultural Students attending the Poona College, existing laboratories would be utilised, and, altogether this scheme recommends itself as being the best to meet existing wants.

432 *It seems necessary now to say a word as to the duties* of the "scientific adviser," and of the assistant chemist I would lay it down, as regards the first named, that he must be given a free hand, and that no one, and no Department, exercise more [illegible] n It is impossible to lay down [illegible] the exact employment of his time. [illegible] his appointment is justified, after due time has been given him to get into his work, but, unless confidence be placed in him to rightly employ his time and opportunities, the appointment is almost sure to end, as many have done before, in not realising what it was intended to I hope, therefore, that if any such appointment be made, the holder will not be called upon at an early date to "justify his existence," [illegible] w as the result of [illegible] n to show, at the [illegible] its continuation is [illegible] e this with having to prove that he is "earning his salary" and usefully employing his time, unless, of course, circumstances should arise which would call for his removal on personal or other unquestionable grounds.

Duties of the scientific adviser' and assistant chemist

With regard to the assistant chemist, his duties must be laid down by the senior chemist, whether it be the carrying out of laboratory work or of instruction, and for the proper discharge of these duties the senior man must be responsible

Should a "scientific adviser" be [illegible] that several industries such as thos[illegible] coffee, sugar, etc, would be desirous [illegible] services, and the question arises whether he should be allowed to undertake private work and to receive emoluments from private individuals in addition to his official pay. It may, with much reason, be urged that industries such as the above contribute materially to the country's welfare, and that their prosperity is co-incident with that of the cultivators and labourers employed in them, so that Government should assist in improving the different manufactures by giving the help of their scientific experts That these industries could be improved by chemical knowledge and skill being directed to them I have no doubt, but there are, it seems to me, great objections to the utilisation of a Government agricultural adviser in technical work when there is so much to be done in a more purely agricultural direction, and when not one district or Province alone is concerned, but the whole of India To properly take up such an investigation as, for instance, that of the improvement of indigo manufacture, the whole time of an expert scientist would be required, and for much more than a single year Then it might be asked,—to *which* of the several industries should attention be turned first of all? My view is that each of these industries should employ its own experts,

and should not look to Government for this. There is quite enough to do in each to occupy special men if selected, and what could be done in a casual way by a man engaged in general agricultural work in other parts of the country would count for but little. But there are other dangers attending the employment of an agricultural chemist in technical investigation. It is only to be expected that if a man be free to take up private work he will choose that which pays him best. More especially will this be the case if the salary attaching to the office be put at a low figure, on the ground of the chemist being able to increase his remuneration by doing outside work. I would point out, moreover, that the inducement to seek private practice will tend to make a man neglect the more special work of his office, and if Government appoint an agricultural chemist with liberty to engage in other work for payment by private individuals, they must not be surprised to find their man select such work as is most remunerative to him, and engage in technical investigations rather than in the direct improvement of general agriculture. Whoever he be, a man is sure to pick and choose what he will *like* to take up, and liberty to engage in private work will, in this case, interfere with the discharge of public duties There is not in India the desirability that occurs in England for having as [illegible] fic skill a [illegible] manures, [illegible] would be [illegible] or nothing beyond it, than to have him, while in receipt of pay for doing agricultural work, endeavour to increase his income by engaging in outside investigations.

However, I would by no means say that if Government thought it advisable that their chemist should take up any investigation concerning a technical industry, he should not be at liberty to undertake it But it should not be, I think, for any extra remuneration, and it should, in every case, come to him as a reference from Government, and with the request that he would, if able to do so, take up the matter in question Any fees received for the work should go to Government For the reasons I have given above, I do not think that any such investigation can be of a prolonged or exhaustive nature, but would have to be confined to the solution of certain definite points which it might be considered desirable to submit to the "scientific adviser" to Government

"Scientific adviser" not to be utilised for Municipalities or as Chemical Examiner

Similarly, I should be inclined to object to the employment of the "scientific adviser," or of the assistant chemist, by Municipalities, for their local purposes, or in the multifarious duties of the office of Chemical Examiner. Such duties are not primarily agricultural, and should be left to men specially appointed to carry them out

The salaries of the scientific adviser and assistant chemist

433 It is necessary that I should now say a few words as to the salaries to be paid to the respective officers whose appointment I suggest Seeing that so much depends upon the standing of the men who are selected, and also upon whether a pension be

or be not attached to the respective offices, it is not possible to say definitely what a proper remuneration would be.

For the senior position, either a man of established reputation and recognised scientific standing may be obtainable, or else the man to be selected must be a somewhat younger man of undoubted ability and great promise, but who has still a name to make for himself. In the former case, I do not think that, leaving out the question of pension, a lower salary than Rs. 2,000 a month, rising to Rs. 2,500 a month, should be given If a younger man is sought, then a salary of from Rs 1,200 to Rs 1,500 a month would be sufficient. These amounts depend much, of course, upon the rate of exchange taken as the basis, when I stated them in India the rupee was then at 1*s*. 6*d*, but it has since fallen considerably It will be clearer, perhaps, if I say that I think the salary of a man of established reputation should be about equivalent to 1,800*l* a year, rising to 2,250*l*. at the end of the term of 7 years, or, in the case of a younger man, about 1,200*l*. a year, rising to 1,500*l* It would be better, however, to do as the Agricultural Conference at Simla in 1890 recommended, and to leave the exact salary to be determined by the Secretary of State, and to be dependent upon the class of man ultimately selected

As regards the salary of the assistant chemist, this, too, must be regulated to a certain extent by the turn which exchange takes, but a salary which is equivalent to 550*l* a year, rising to 700*l*. a year, should be sufficient to attract a suitable man.

434 There are other matters of detail which might have to be Ot er de ai s arrangement
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first point I can hardly offer an opinion, but as to the second, I am almost sure that it will be necessary to go beyond India to find suitable men, at least for the senior appointment, while on the third point I would throw out a suggestion that, if the selection be made from England, it might well be left to the Secretary of State in consultation with some agricultural body of standing, such as the Royal Agricultural Society of England

While an assistant chemist will be readily obtainable, I am well aware that it will be no easy matter to find a man in every way
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discovered. In the end it may be necessary to select a man of the required scientific qualifications, and who appears likely to be able to develop the practical qualifications after he has acquired some experience in India. But, unless there has been beforehand
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the primary requirement is that he shall have gained the special experience before coming out to India, and if he be a man of intelligence and good common sense he will be able to see what is wanted of him, and to add practical knowledge to his scientific ability

I am conscious, too, that it may be said that in giving a man so free a hand as that which I have suggested he should have, I have left a good deal open to him, and have put but little control over him It is quite true that this leaves much to chance If a man be active and devoted to his work he may make his position one of much value, and render its continuation indispensable, if on the other hand, he only studies his own comfort, he may simply make his appointment a "cosy berth" which brings him in a good salary, so long as it lasts It is so difficult, however, to impose any system of control without at the same time destroying the practical usefulness of the appointment, that I think it is better to rely upon the individual to show that his selection and the creation of the office have alike been warranted

The employment of other scientific men in agricultural enquiry

435 I should be misunderstood if I were supposed to imply that all that is needed for scientific agricultural enquiry in India is an agricultural chemist and an assistant chemist The branch of science with which I have had most to do is chemistry, and so I have spoken mainly from the standpoint of the chemist But there is need of men expert in other branches of science too Among these, a Botanist, an Entomologist, and an Agricultural Engineer might be mentioned Such men may be found in India itself, and from time to time their services have been utilised, but,

several lengthy enquiries, more especially that with regard to the

China. In all matters concerning the trial of new crops or new varieties of crops, recourse should be had to the best botanical assistance available, and there are, as I have said, men in India fully qualified to give this,

Agricultural Chemistry.

Already, at the Forest School,

idian Museum, Calcutta, has been employed in giving a course of lectures on this subject So far, this is good, but it only covers a period of six weeks in the year, and Mr Cotes has the general duties of his appointment at the Indian Museum to attend to as well as the more agricultural relations of the subject. I heartily approve of the employment of men of attainment in different branches of science for the furtherance of agricultural knowledge and also for teaching purposes, but this must be done on a more extended scale than has been the case up to now, and there should be, as I have said, both

a Botanist and an Entomologist attached regularly to the Agricultural Department

A more thorough step towards attacking a great subject affecting agricultural interests was taken in the engagement of Dr Lingard as Government Bacteriologist, and in his location at Poona (*see* paragraph 272) This appointment had only been made shortly before I left India, but of the necessity of applying the latest advance of science to the investigation of cattle diseases there can be but little doubt.

In many enquiries of an agricultural nature, questions will arise where a knowledge of engineering will be very essential Such, for instance, are those on land reclamation, irrigation, etc Reference has been made to the employment, in some of these enquiries, of Mr W J. Wilson, of the Public Works Department It would be well that the services of an agricultural engineer should be available, not only from time to time, but regularly, for the work of the Agricultural Department

The position of scientific men in India.

436 The consideration of the various points raised in this chapter leads me, in concluding it, to make a few remarks on the general question of the appointment of scientific men to positions in India There ought to be no reason why India should not possess her own staff of workers in various branches of science, instead of having so often to refer questions to home *experts* There should be authorities on scientific subjects in India just as there are in England, in Germany, and in other countries It cannot be said that encouragement is given to the pursuit of scientific investigation in India, and if the history of the many very able men, including even a Second Wrangler at Cambridge, who have gone out to India to fill appointments, be examined, it will be found that in but few cases have they advanced by the pursuit of the particular sciences of which they went out as exponents The fault seems to lie in the fact that men skilled in a special science, and for that reason selected for India, mostly find themselves, on arrival drafted into the Educational Department, and forming part of a graded service. In this capacity they are obliged to move on through the different grades, taking up the respective duties of each of these, for, if they wish to keep to their own science, they must remain at the same salary as at the commencement The outcome of this has been, that men who might have been original workers in science have had to abandon it for the duties of School Inspectors, or, despairing of further advancement in their own science, have launched out into the pursuit of Meteorology and other subjects in which they might earn distinction I have it from men in the Educational Department who had been originally chosen for their scientific knowledge, that, when once established in a position, they find their time so taken up with teaching subjects *other than* their own science, that they have to abandon entirely the hope of doing any original work, and have not

Want of original workers in science.

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ot keep their

knowledge up to date The late Mr S A. Hill, of Allahabad, who was a skilled chemist when he came out to India, acknowledged to me that this was the case and that he had not been able to keep himself acquainted with the advance made in chemistry, still less to carry out any original work in the science.

Unsatisfactory method of Chemical Examinerships

Another instance of the way in which no encouragement is given to scientific study is seen in the system by which appointments are made to the position of Chemical Examiner Instead of selecting for these posts men who have been carefully trained in chemistry, and more especially in analytical chemistry, the appointments are generally given to men who have had nothing more than the class instruction in chemistry and the test tube experience of the ordinary medical student Those who have any acquaintance with the facts know how small are the demands made upon the chemical knowledge of a medical student in order to enable him to pass his qualifying examinations, and it is simply this or the recollection of it, which the "Chemical Examiner" in India has to rely upon when he enters upon his work The men chosen are medical men who, when they see the chance of adding to their income by taking a "Chemical Examinership" as well, do so, and at once find themselves armed only with the remains of their student days' knowledge brought face to face with matters requiring not only special acquaintance with chemistry, but also considerable analytical skill and experience The subjects dealt with by Chemical Examiners are of a most varied description, from poisoning cases in which human life is at stake, down to analyses of Government stores, dynamite, kerosine oil, beer, raspberry essence disinfecting powders, and lozenges! Clever

[illegible]

know how to deal with the usual run of things submitted to him and what he does not know he finds out from books But the system is very far from being satisfactory, and it is not to be wondered at that the Reports of the Chemical Examiners are not fully credited in the Law Courts On looking over the Reports, I find that medico legal cases and examination of Government stores form the bulk of the work, and that the important matter of the adulteration of staple foods is one which but seldom comes forward

[illegible]

Municipal chemists

anyhow Added to this, the number of samples sent, and the kind of analysis made are determined rather by the cost than by the importance of the enquiry, and it is left to the chemist just to

analyse what is sent to him, instead of carefully selecting such samples as shall be germane to the enquiry.

Central Training Institution for public scientific appointments

I cannot but think how much better it would be if there were one Central Institution, say at Calcutta, where, with able professors and the best laboratory accommodation, men might be trained so as to qualify for filling the posts of Chemical Examiner, Municipal Chemist, Sanitary Inspector, and such like. As vacancies arose in these posts, they might be filled by men who had passed out with a qualifying certificate. In such an Institution, too, men might be trained in knowledge of agricultural as well as of general chemistry, and the requirements of India could in this way be met from India itself, and not be the subject of continual reference to England. In some such way, too, there would be an opportunity for the development of original scientific work in India.

CONCLUSIONS

CONCLUSIONS

437 The influence of science upon the development of agricultural knowledge has been very marked within the last half century. Inasmuch as chemistry is the branch of science most nearly related to agriculture, its study becomes of particular importance when the improvement of agriculture is concerned The need of having an agricultural chemist in India has been recognised alike by the Government of India and by individuals of weight in that country There is scope for the useful employment of an agricultural chemist in carrying out scientific investigation upon agricultural problems of the day, in planning and regulating agricultural enquiry and experiments, and in examining and recording the results, in maintaining the continuity of experimental work, in acting as a "referee" or "scientific adviser" to Government on all chemico-agricultural matters, in directing the teaching of agricultural chemistry, and in aiding the spread of agricultural education by assisting in the issue of agricultural text-books

A beginning should now be made by the appointment of an agricultural chemist to carry out the above duties He should be a man with special acquaintance of the science and practice of agricultural chemistry, and should possess a good general knowledge of practical agriculture The appointment of such a man should be regarded as experimental, and, accordingly, it would be sufficient to have only one man at first, who, while acting as "scientific adviser" to Government, would, nevertheless, be equally available for all the Provinces of India He must be given time and opportunities for making himself acquainted with the conditions of Indian Agriculture, and the first appointment should not be for less than seven years. His functions should be primarily those of an investigator and adviser, and not those of a teacher He should be provided with a well-equipped laboratory, and with an assistant chemist who shall be resident at the laboratory, do the necessary analytical work, and also teach Agricultural Chemistry. The most satisfactory plan would be to utilise the existing laboratories at Dehra and at Poona, each for six months in the year It is not advisable that the "scientific adviser," or the assistant chemist, be allowed to engage in private work for individuals.

Further, it is very desirable that men of mark in other sciences such as Botany, Entomology, Engineering, etc, should be attached to the Agricultural Department for purposes of enquiry and experiment

RECOMMENDATIONS

RECOMMENDATIONS

438. That an Agricultural Chemist be appointed for India, to act as adviser to Government in chemico agricultural matters, to carry out investigation, and to direct Experimental Enquiry

That an Assistant Chemist be appointed, to act under the above officer, and to teach Agricultural Chemistry.

That to the Agricultural Department should be attached other scientific officers, such as a Botanist, an Entomologist, and an Agricultural Engineer, for the purposes of Agricultural Enquiry

CHAPTER XVIII.

EXPERIMENTAL FARMS.

The causes that have led to the establishment of special Experimental Farms

CHAPTER XVIII.

EXPERIMENTAL FARMS

439. It may be said that wherever the work of agricultural improvement has been taken in hand, the establishment of an Experimental Farm has almost invariably been a part of the scheme. There are very good reasons, too, why this should be the case. Upon the carrying out of the ordinary operations of the farm at the most favourable moment depends the success of husbandry, and it has been found, over and over again, that this is hampered by the concurrent existence of work of an experimental nature, involving special care and expenditure of time. When a farmer's pocket is concerned it is hard to expect him to leave that upon which his living depends, and to attend to voluntary and unremunerative labour. When a wide stretch has to be sown at a favourable turn of the weather it is troublesome to have to delay to plan out an area, to measure out plots, to mark out paths, or to weigh out seed or manure; similarly, at harvest-time, when so much depends upon getting in a crop well, it seems to involve tedious delay in cutting and gathering plot by plot, in stacking and storing separately, in numbering, labelling, measuring, weighing, recording and checking the produce of different small areas; so it comes about that, under the press of sowing or harvest operations, the experimental area is too often left to the last, and that which requires the most care is neglected, because there is not the time to give attention to it. The outcome of this has been that, even in England, the ordinary farmer will do little more than leave, perhaps, a bit of his field unmanured while the rest of it is manured, or he will put some particular dressing on one spot, while the remainder is treated differently, and at harvest time he will merely judge by the eye what the result has been. But he will seldom go to the trouble of harvesting separately any definite area in order to learn precisely what its produce has been as compared with another. Accordingly, the information thus gained is known to the individual only, and even this is of an indefinite and unrecorded nature. Experimental enquiry has thus been left to those whose opportunities or means have permitted their sacrificing a certain amount of time and money, or else to agricultural bodies or Government Departments. Even where private individuals of means have undertaken experiments, there has been felt the need of guidance and supervision, of accuracy and skill such as is not generally met with in the ordinary staff of a farm, and it is now fairly admitted that, unless an experiment can be separated from the ordinary farm work, and have a man of special ability set over it, and made responsible for watching it and for accurately carrying it out, it is almost vain to expect tangible results. This has led to the confinement of experiment mainly to

special places, such as Experimental Farms, or to the conduct of experiments under the guidance of men of scientific repute This has been the case not in England alone, but in France, Germany, Italy, and other countries, so also in India Indeed the circumstances that have led to this result tell with more force in India than elsewhere ... vision of the land and ... Experiment has to ... t from the ordinary work of a farm, it must not be hampered by the latter, and has to be judged apart from the financial expenditure incurred

In the present chapter I intend to review the past working of Experimental Farms, and to indicate in what ways improvement in the system may be effected

Past work of Experimental Farms in India

440 That mistakes, and many mistakes, I might say, have been made, admits of no doubt, but that more mistakes have not been made, and that a far greater expenditure of money has not been incurred, appears to me to be still more a matter of wonder when it is considered what has been the agency at work in the past With no scientific guidance, with no one skilled in agricultural experimental work, and with nothing but the direction of men having experience of English practical farming only, or of Civilians who have not even had this, I am only surprised that so much has been accomplished. Generally, let me say that, after what I had heard before coming out to India, and what I heard in India itself, I found Experimental Farms to be very much superior to what I had been led to believe I should find them It has been my lot to inspect experiments in England with which many of those in India would compare very favourably There have been, without doubt, a few men in India who have possessed a scientific spirit, and who have been actuated by a desire to work out agricultural improvement The failing has been that the agency has been imperfect, and the continuity uncertain Either the practical knowledge or else the scientific skill has been wanting, at all events, I do not know a case in which both have been combined in the one individual, or where there have been two individuals at work, one skilled in the one, the other in the other direction In experimental ... practical ... ivilian, ... ific skill ... Farms has been, in great measure, a compilation of numerical results rather than of tangible conclusions, an indiscriminate mixture of good with bad towards the sorting out of which little or no real help has been given It is not enough to state merely what has been done and what results have been obtained, but the results require to be criticised digested, and presented to the public in a form which can be understood at a glance People not directly interested will not and should not be expected to wade through all the details of an experiment, to hear of this or that failure, but they do want to get at the gist of the whole, and to have it presented to them in an assimilable form The conclusion I have

formed as to Experimental Farms is, that there has been a lot of good wo[illegible] d as to be almost [illegible] is what is requi[illegible] But that Experimental Farms have been useless and extravagant institutions I am very far from admitting, or that the men who have directed them have been incapable men generally, I would not for a moment allow Where failure has followed, it has been mainly because the conditions for success were not present The faults are those which could be remedied by the employment of scientific and practical skill, and by having a continuous instead of a shifting agency

The expenditure upon Experimental Farms

441 *It cannot with justice be said, I think, that, on the whole,* the expenditure upon Experimental Farms has been large Here and there instances may be pointed out where excess of zeal has prompted excessive expense but the same might, with far more justice, be said of other experiments of Government besides Experimental Farms When, in April 1884 an enquiry was ordered into the conduct of agricultural experiments on Model Farms, the replies received did not indicate that there had been any serious waste of money, although it was allowed that if economy were called for, it would be necessary to distinguish between what was purely of an experimental kind and what was rather of the nature of demonstration, also that whereas the latter might reasonably be expected to pay expenses, the former must of necessity call for direct expenditure

Distinction between Model Farms and Experimental Farms

442 My plan will now be firstly, to indicate the general lines upon which Experimental Farms should be conducted, and, secondly, to illustrate the various points by reference to existing Experimental Farms in India

I wish at the outset to clearly distinguish between Farms which exist for the purpose of demonstration and those which are intended for pure experiment The former are intended to show to cultivators the result of a practice found by experiment to [illegible]

test stand on a different footing altogether The object at these latter is to find out *which* of several practices may be the best and this of necessity involves doing a great deal that is of an unremu[illegible] is out of [illegible] highly [illegible] ntend to [illegible] purely Experimental Farms

Where Experimental Farms are needed.

443 *The Need of Experimental Stations or Farms* —That such are needed I have already sufficiently shown I have enumerated the reaso[illegible] ing out experimer[illegible] T para graph 40[illegible] putting them to [illegible] take the

general need as granted It is, however, a different question *where* such Farms are needed This has to be settled for each Province and for each district separately To establish an Experimental Farm in a district, simply because, in the abstract, it is a good plan to have a place for trying experiments, is not a sufficient reason The decision must be partly based upon cons derations as to whether there are the means to support a Farm, and whether there be a suitable staff, but the main one should be whether there is any thing definite to learn, any particular question to solve, and whether this has any relation to the agriculture of the country around Unless these questions can be answered in the affirmative, the need for an Experimental Farm has not been made out A *primâ facie* case must be established for the existence of such a Farm in any particular locality.

444 *The Supervision required*—Unless there be competent supervision there should be no Experimental Farm This supervision should consist of, firstly, a Director, who may be the Director of the Provincial Department of Land Records and Agriculture, or his Assistant Director where one exists, secondly, a resident Farm Superintendent or Manager who shall see to the actual cultivation and to the carrying out of the details, thirdly a scientific officer who shall be available for the purpose of advising and of assisting in the examination of the results obtained and also of [illegible] The necessary supervision.

should not be established

The Bengal Agricultural Department has attempted to carry on experiments by Assistants employed in the Department These Assistants from time to time leave their office employments in order to visit the Experimental Station for the purpose of seeing how the work is going on I found, however, in one case, that the Farm had only been visited once in the course of the year Such occasional supervision is of little practical value, especially when, as in the instance under notice, the resident manager was a man of very ordinary calibre, and had other estates to look after and other duties to perform When, however, as in the case of the Cawnpore Farm, and those at Nagpur and at Bhadgaon, the resident manager is a man of ability, an occasional visit from a responsible Director is all that may be wanted, but I am very decided upon the advantage of regular inspection and control by individuals directly responsible

445. *Situation of an Experimental Farm*—An Experimental Farm ought to be so situated as to be readily accessible to those who are likely to visit it Thus it should not be too far distant from an important centre, and yet it should be amid agricultural surroundings If these *desiderata* be fulfilled the Farm may be a useful ground of ins [illegible] ld also be readily reached by [illegible] who may supervise it, and to w [illegible] mportance In this respect with the exception of Bhadgaon and, possibly, Seebpere, existing Farms in India are well placed Bhadgaon is, however, The situation of a Farm.

too far away from a railway station, besides being a difficult place to get to, owing to rivers that have to be forded, Saidapet is too near the town of Madras, Seebpore also is perhaps too near Calcutta and too much surrounded with dwellings, besides not being in a sufficiently agricultural district

The kind of soil

446. *Soil suitable for an Experimental Farm* —Where the object is not merely to have a Farm for the conduct of scientific enquiry, but to do that which shall be for the benefit of the surrounding agriculture the land chosen should be composed of soil which is fairly typical of that of the country around, so that the results may be applicable to as large an area of similar land as possible If there be two or more main types of soil in a Province, this will constitute a reason for having more than one Farm in it, provided the requisite supervision be available But to take up, on the one hand, land which is naturally so rich as to call for no improvement, or, on the other hand, land so poor or so sandy that no one would think of farming it if he could help it, is to render experiment profitless from the outset The Saidapet Farm at Madras is, by the very nature of its soil, quite unsuited to be an Experimental Farm of benefit to the Presidency in general It has a poor, hungry, sandy soil, and the land is little better than a great sandhill in no way typical of any large extent of land throughout the Presidency About other Farms I have no adverse remarks to make in this respect

When a site, however, is to be chosen for purely scientific investigation, closer discrimination than is supplied by local considerations is required Thus, if an experiment on the power of a certain manure be devised, the soil must be one that is neither too rich nor too poor It must not be so rich that the influence of manures on it will not be marked, nor so poor that on this account it is not ordinarily culturable nor intrinsically worth improving In brief, it must be a soil that responds fairly to the action of manure.

The size of an Experimental Farm

447 *Size of an Experimental Farm* —When an Agricultural Department or other agricultural body contemplates taking up an area of land for purposes of enquiry and experiment, the question as to the most suitable size of the area calls for careful consideration This must be decided upon with regard to the exact purposes which the area is to serve, and the nature of the experimental work to be carried out If experiment only is to be undertaken, and to be confined to such work as the growing of new crops and new varieties, or the effect of different manures on crops quite a limited area will do A Farm of 20 to 30 acres would be quite sufficient in such cases and even a smaller one might do Similarly, for more strictly scientific investigation there would be no need to take up more than, say, 10 acres In the experiments at Woburn, which I have under my care on behalf of the Royal Agricultural Society of England, the main experimental field is 7½ acres in extent Generally speaking, I would say that, for purely experimental work in crop growing or in manuring, 25 acres is a good size for a Farm, and it would be better to confine the area to this, and to limit the expenditure

.th all the accom- etc. In short, I was actually required for the contemplated experiments and for their probable extension The larger an area is, the greater are the chances of variation in the soil, and these variations are likely to tell most injuriously when comparative experimental trials are being made, or when scientific investigation is concerned

The objection urged against such small Farms is that they could not pay for the necessary superintendence, whilst larger ones might, and at the same time give the Superintendent enough to do. In such cases it would not be difficult to add to the purely Farm ex- ure, such as the breeding of cattle, dairy farming, silage-making, or the cultivation of crops on a practical scale, according to different existing or newly-introduced systems. In such cases an area of 25 acres would be manifestly insufficient, and the Farm would require buildings, cattle, pasturage perhaps, and it should also be able to supply the necessary crops for the maintenance of the stock, whilst, when comparative crop-growing systems are tried, the difficulties attaching to the use of small plots may be sufficient to prevent their practical adaptation to the purposes of the enquiry The farm, though really an Experimental Farm in design, becomes then one the greater part of which is cultivated in the ordinary way, and a portion of it only is kept as a purely experimental area An extent of 100 acres, or even more, may thus be requisite, but I do not advocate more being taken up than is really necessary, and I do not favour the establishment of such large Farms as that at Bhadgaon (Bombay), which covers 1,200 acres. A great deal of time and labour must necessarily be involved in doing the ordinary farm work apart from what the experimental area specially requires, and the risk attending the gathering-in of a crop at the proper time is too much, and the expenditure incurred too great, to prevent economical conditions from entering. It would be better not to hamper the Superintendent with more ordinary farm work than he can see to without neglecting to give due care to the experiments, and it would be wise to set apart a certain sum yearly for the purpose of experimental enquiry, and to consider it as an expense, rather than to expect a Farm Superintendent to make his farm pay by virtue of the superior cultivation of a large area exceeding the extra cost involved in conducting experiments over a portion of it The farm at Woburn, which, by the Duke of Bedford's liberality, has been placed at the disposal of the Royal Agricultural Society of England, is 130 acres in extent, and of this about one half is utilised for experimental crop-growing and for feeding experiments, the rest being in pasture, or else used for growing ordinary farm crops. The experiments, however, in every case occupy the first place, and everything else has to be subordinated to them Feeding experiments on cattle and sheep

are conducted every winter season: exhaustive enquiries on ensilage have been made, and yet ample room has been found on the area of 130 acres for all purposes of experiment. I have, therefore, every reason for urging that farms for similar purposes in India should not be hampered by the occupancy of a large area, and also for saying that 100 acres or a little more will be found ample for all practical requirements

It may sometimes be thought desirable, in addition to a purely experimental area, to have a "demonstration farm" or "model farm" attached, where may be shown, on a practical farming scale, the results of what has been found successful upon the Experimental Farm In that case the area to be taken up may well extend to, say, 50 acres Or, with the Experimental Farm it may be desirable to include a seed-growing farm, whereon seed for distribution to cultivators may be raised. This has been done at Cawnpore, the experimental area covering 42 acres, and the seed-growing part another 12 acres, besides which an additional 50 acres is used as a fruit and vegetable garden. The combination of two such objects is, I think, very desirable for Agricultural Departments to carry out, but I would like the two to be, as at Cawnpore, quite distinct. It is impossible to state what area could be usefully employed, but, speaking broadly, 50 acres should be about sufficient in most cases at beginning, leaving it to be extended should occasion arise

The size of an experimental field

448. *Size of an Experimental Field.*—The size of a field should depend much upon the suitability of the situation and the nature of the soil. Thus, if 10 acres of land were required, it would be better to have two level areas of five acres each, than to have a consecutive stretch of 10 acres on land of uneven character. Similarly, if the soil varied greatly in character, or if on the same area were parts typical of two different classes of soil, two blocks in different parts would afford more information than a single one

Conditions of experimental field.

449. *Conditions relating to an Experimental Field*—The experimental field itself must be as level and uniform in character as possible; one part must not be on high ground, another on low ground, otherwise water may lodge on the lower level, or the surface soil from the upper may be washed down to the lower level; the soil must not be deep in one place and shallow in another, but fairly uniform throughout; similarly, the soil must be of the same quality, as nearly as can be judged, all over the area; trial diggings should be taken over the field, in order to see that there are not great apparent divergencies in these respects; the plots themselves should be removed from the influence of trees, hedge, or shades, which may affect them unequally or adversely.
Th [illegible]
if [illegible]
I r[illegible]
bee[illegible]
or [illegible]

taking up a new area, is to grow the same crop over the whole of it for a season previous to commencing the experiment proper By reaping the first year's crop over different parts of the field and weighing it, it can be ascertained in the most practical way whether the field be uniform or not. If wide discrepancies appear, then it is quite sufficient evidence that some part or else the whole of the field is unsuitable for experimental purposes. I am quite certain that many of the seemingly contradictory and peculiar results obtained at Experimental Farms arise from neglect of a precaution of this kind and that time, labour, and expense might be saved in the end by the sacrifice of one year at the commencement, in order to ensure that the area chosen be a suitable one in the matter of being equal in crop-producing power.

450. *Plan of Experiment.*—A suitable site, an uniform field, and efficient supervision being provided, the plan of experiment may next be drawn up It is greatly from want of having a definite plan and a definite object in view that experimental work in India has failed In the majority of cases (and I would mention the Dumraon and Seebpore Farms as examples, though the same might be said more or less truly of the others also) the leading idea, when an area has been found available, has been to cover it with as many experiments as it will hold, regardless of the possible developments that may take place after the experiment has once been started. This position, I know, has, to a great measure, been forced upon those who are in charge of such Farms, and they have been expected to evolve as many results as possible in the shortest time, and the abundance of experiments in progress has been the criterion of activity rather than the intrinsic worth and accurate carrying out of those that have been undertaken There is a common impression that an experiment can be carried out upon the first subject which suggests itself, and that the more varied the forms be in which it is presented, and the more numerous the plots which compose it, the more valuable and exhaustive the enquiry must be. This may be, and generally is, an entire mistake. Plan of experiment.

451. The ... is to have a definite obj ... als so that they may best ... Two main divisions of experimental enquiry.

Now, experimental enquiry may be of two kinds.

Firstly, it may be more specially scientific in character, such as the finding out of fresh scientific truths or the testing of scientific theories. These experiments can only be carried out under the immediate ... such as the ... arrangement ... to him, and they cannot be made distinctly popular, or be always set out in such a way as to clearly demonstrate to everyone the line of enquiry pursued Briefly, they need such explanation for their right understanding as only a specialist can give. The area occupied by investigations of this kind will, however, be but Scientific investigation.

a limited one, and they may frequently be even of a laboratory character. Of this nature are for example experiments on the nutrition of plants, the assimilation of different soil constituents or of atmospheric gases by plants, the exhaustion produced by continuous cropping, or the effect [illegible] ating salts. These find their count [illegible] distinctly scientific experiments c [illegible] John Lawes and Dr Gilbert and to a lesser extent in those at Woburn.

Practical experiment.

Secondly, experiment may be of a more practical kind, such as the testing of the value of different processes already in use, the economical effect of various manurial ingredients upon particular crops, the collection of information regarding the outturn of crops, the growth of new crops and new varieties, the trial of new implements. For these considerably larger areas will be required than for the more scientific investigations.

Experiments must have a bearing upon actual agricultural practice.

452. Whichever be the kind of experiment, in each alike a definite plan must be set forth. For the existence of this, in scientific investigation the expert himself may be trusted, and it may not be possible, as noted previously, to indicate this to the comprehension of everyone. But in the practical experiments the object and the plan should both be set out clearly and unmistakably. I may be allowed here to give a few hints illustrating them by what I noticed at Experimental Farms in India. The first requirement is, that every experiment should have a distinctly practical bearing, in other words it should consist of the trial of something which should success in the experimental stage attend it, will be capable of practical application to the farming of the country, and effect an improvement in it. There must be some *primâ facie* ground for believing that what is tried by the experimenter may be carried out by the cultivating *raiyat*. Thus, a manure might be tried which the *raiyat* is not able to get either because it is beyond his power to purchase or because it is not obtainable in sufficient quantity, an implement might be experimented upon, which would always be beyond the *raiyat's* purchasing power, a crop might be grown which would be of no use to him or which his prejudice would prevent him from touching. In all such cases the experiment could do but a limited good, and often no good at all. Yet [illegible] on [illegible] a [illegible] ed in the past.

Manures employed should be those in common use.

At the Cawnpore Farm I found that the best result in wheat-growing, and also in potato-culture, had been derived from the use of wool waste. But, on enquiring where it could be obtained, I heard that it came from a manufactory near by, and that the Farm took the whole of the waste. There are but few such factories in India, and the amount of wool waste produced is insignificant. What good can it do the *raiyat*, therefore to know that, in order to get the best crop, he must use what is not even an obtainable article? In another experiment I found that muriate (chloride) of ammonia was used, a material far beyond the power of the *raiyat*

to get, whatever might be the benefit to be derived fr[illegible] this, the muriate is one of the dearest forms in wh[illegible] be purchased Also, I saw plots on which th[illegible] indigo manufacture, called *seet* water (see paragraph 5[illegible]) But it is only here and there that *seet* water can be [illegible] Again, for an experiment to have been properly condu[illegible] for comparison with the one treated with *seet* water [illegible] had supplied to it a corresponding volume of [illegible] order to make the trial a fair one, but I could not [illegible] had been done The manures to be tried on Experimental [illegible] should be those which are within the power of th[illegible] and which are in general use throughout the country [illegible] of which there is some likelihood that use will [illegible] future Expensive chemical manures imported from [illegible] at present have no place in the *raiyat's* farming system [illegible] fore, they should not be included in practical experi[illegible]

[illegible]

cultivators, and it should be only under very special [illegible] such as the preferment of a request [illegible] should be tried, which should induce the [illegible] mental Farm It may be desirable, perhaps [illegible] threshing machine would pay to use in the [illegible] sold in bulk or of its being required clean, [illegible] large Estates But these are exceptional [illegible] form a part of the ordinary duties of an Experimental Farm [illegible] primary object at which is to attempt [illegible] [illegible] [Po]ona Farm I saw [illegible] [w]ell, there was [illegible] It may be said, [illegible] though a crop or even an implement may not be [illegible] able, a use for it may be found later on, such as [illegible] potato, a crop first despised but now largely grown [illegible] information may sometimes be gained which may [illegible] wards, I would urge that, in the main, the principle I have [illegible] ciated should be kept in view

453 Experiments should be as simple as possible, they [illegible] be self evident, and ought only to need the minimum of explanation It is not a good experiment which has a great many [illegible] resulting from it, an experiment is not enhanced in value by reason of the many items that contribute to it, or of the many plots which are taken up in its demonstration There should be clear and definite issues involved and one only rather than a number Each plot of an experiment should be set to answer some definite question, and each should be essential to the enquiry and not be merely one of a number making up the series If it be desired to bring out the influence of any particular manurial ingredient or chemical element, the presence or absence of that ingredient or element should be the one varying factor among conditions otherwise alike.

In manurial experiments the principle should be aimed at

454 When manurial experiments are tried, it is is not enough to mark out a number of plots upon which the same crop is grown and to apply the manures indiscriminately, without relation to one another, the soil or the crop Something more ought to be sought for than to know that this particular manure is better than that one, the *principles* of manuring ought to be aimed at, and the endeavour should be made *to find out why it is, or what it is in one* that makes it superior to another. The principle being involved, the application of it to other materials embodying that principle, or to altogether new ones, may constitute a further, and possibly advantageous, advance in practical knowledge. But if, as I noticed at Dumraon, at Nagpur, and elsewhere, a number of manures be chosen without regard to their composition or nature, such as *bones, lime superphosphate, saltpetre, etc*, only empirical knowledge as to these particular materials will be obtained, and not that of the principles in accordance with which they and others like them may prove useful Comparisons should be made upon some clear basis, thus, farmyard manure, green manuring, and night-soil have a certain affinity, in that they all are what one may term "organic manures", but bones and nitrate of soda have no affinity, nor yet has lime to either of the others *It may be well to try whether phosphatic* manures or soluble nitrogenous salts are required for a crop, and then bones might be tried against nitrate of soda, but bones would be hardly sufficient in themselves to test the question, and other forms of phosphatic manures should be tried as well A further question may arise, *viz*, in what form is phosphoric acid best applied, or in what form should nitrogen be used? Each of *these calls for an experiment by itself, which, when solved, may be* turned to the elucidation of the original enquiry

Comparisons should be made on a clear basis.

An area once manured is for a time afterwards rendered useless

455 The *setting out of the plan of an experiment, therefore, is* not such a simple matter, and needs more knowledge and experience than the amateur agriculturist is able to command Nor must it be forgotten that when an area is once covered by a manurial experiment it is most certainly spoiled for future experiments for some little time to come inasmuch as the manures are not dissipated at once, but their effect will, as a rule, be seen on *subsequent crops as well I have constantly found this principle* ignored, and experiments have been started afresh on ground which has been variously manured during the progress of a previous trial The essence of a comparative experiment is, that all the plots should start fair and level Yet I find that at the Nagpur Farm *a complete manurial series was conducted for several years in suc*cession with manures thoroughly divergent in character, such as saltpetre, bone-dust, cattle-dung, green manuring, etc, and then the series was exactly reversed, and manures were put on where others, quite different in nature, had been previously applied, the land meantime having had no opportunity of resuming its equality of producing power Satisfactory results in such a case could not be expected

Previous treatment and

456 At the Poona Farm an experiment was being tried with *judr* (millet), but over one half of the area sugar cane had been the

crop, and over the other half, gram (a pulse). Such previous uneven treatment of the land is quite enough to interfere with the success of an experiment. Manures should be chosen with reference to the soil and the crops, and, in drawing conclusions, it should be borne in mind what the conditions are Thus, a soil rich in vegetable matter would not be the one on which organic [illegible] order to be sound, must not be laid down without reference to the particular conditions that prevail at any one spot.

relation to soil and crop should be considered

457. I am in favour of having what I saw at the Experimental Farms at Cawnpore and at Nagpur, *viz*, a continuous series of manurial experiments on some one or more staple crops, such as wheat, cotton, sugar-cane etc, the same crop being grown and the same manures being put on year after year. It may be said that this would not occur in practice, as a rule, but it is the way in which the best information is brought out as to the requirements of the particular crop, and also as to the effect of the different manures used, the varying influence of seasons is eliminated, and accidental occurrences are corrected by the sequence of several years Yet this plan must be intelligently carried out, and not in the way that it was done at the Experimental Farm of the Nadiad Agricultural Association Mr Ozanne had, at the beginning, laid out the line of experiment, intending the Association to try it upon the general rotation adopted in the district, but, the crops having been once sown and the manuring put on, both were continued year after year afresh, just because the ' Director *sahib* ' had started it in this way On coming there again, some years later, Mr. Ozanne found the appearance of the field just as he had left it

The advantage of a continuous manurial series with one crop

458 Occasionally, feeding experiments have been undertaken For example, at Saidapet Farm (Madras) I saw a pen of four sheep being fed on earth nut cake with other foods, and four without any cake Again, at Poona it has been attempted to gauge the relative milk-yielding qualities of cows of different breeds by taking single specimens of each To anyone who has had experience of experiments with cattle or sheep it will be readily apparent that to attempt to draw conclusions from four sheep or from a single cow is almost worse than useless, in fact it may often be totally misleading The "personal equation" with farm animals is so great that, unless a sufficient number be experimented on, no proper conclusions can be drawn Animals forming a part of an experiment must be of the same breed, the same age, and the same up bringing, as nearly as possible In the Woburn sheep experiments the number of sheep forming each pen is from 20 to 30, and I should not like to take a smaller number When cows are concerned, there come in further considerations as to the date of calving, the time of year, and other fluctuating circumstances which render absolute experiments with milking-cows a very

Feeding experiments.

[illegible] In the Rothamsted experiments on [illegible] milking-cows, Sir John Lawes [illegible] th less than 30 cows in each set. Of course these last experiments were for absolute accuracy, and I would not say that useful general information could not be obtained with a considerably smaller number of animals; yet it is quite hopeless to attempt it with half-a-dozen sheep, or with two or three cows.

Illustrations of experiments to be tried.

[illegible] of having practical [illegible] possible, and involv- [illegible] ments which are of this nature, and a plot cultivated or manured in one way placed side by side with another cultivated or manured differently may afford more information than any elaborate series offering several [illegible] T[illegible] st good will, I believe, re- [illegible] native practice and another [illegible] Of this kind are the follow- [illegible] oughing; thin seeding *ver-* [illegible] putting in the seed, differ- [illegible] s of cultivation; irrigation [illegible] green-manuring with vari- [illegible]

Native and introduced implements must be placed side by side.

Similarly, in the case of trials of implements. It is not enough to exhibit a new implement and to show what it can do by *itself.* *It needs to be put side by side with a native one,* and, indeed, the cultivator, before he is persuaded of its value, must work the two himself side by side on his own holding, otherwise he will go away from the Experimental Farm or the Agricultural Show and content himself with merely saying what a good implement the new one is, but without the least intention of replacing his own by it.

The advantage of simultaneous experiment in different parts

460. One great advantage of having all experimental work under the general survey of a "scientific adviser" is that, by this means the same experiment may be concurrently tried over different parts of India. In this way general truths may be obtained for the whole country instead of for one particular spot only. A uniform result would be of far more lasting and wide-reaching benefit than more numerous ones which might be the outcome of the peculiar circumstances of special districts. I would much rather see a joint conclusion of this kind arrived at as the result of experimental work on Farms than the many and often conflicting conclusions which are now drawn

The size of experimental plots

461. A few words may be said in regard to the plots themselves and their arrangement in an experiment. First, as to their size. In this respect I have not much fault to find with what I saw in India. As a general rule, I might put it that the maximum size of a plot should be one acre, the minimum size one-tenth of an acre. For merely trying new crops or new varieties of crops, considerably smaller plots might be used, but where there is anything of a strictly comparative nature to be tested, I do not think that it is

thoroughly satisfactory to take less than one-tenth of an acre. I am well aware that much has been said as to the convenience of quite small plots, and of "pot culture" as against field trials, but "pot culture" requires far more constant and special watching than field plots, and small plots are liable to many more extraneous and accidental disturbances than larger [illegible] Th[illegible] of the crop of a small plot into the acreag[illegible] multiplication over and over of every [illegible] become a big one when taken on the [illegible] contend, the crop is not a fair index of the acreage yield, for along the edges of a plot it will always stand higher than elsewhere, having a wider area from which to draw nourishment, on the other hand, injury to a single plant either by insect or vermin pest or by disease will affect the produce of a small plot, whereas on a good-sized one this will be immaterial I well remember being taken over an Experimental Station in England which was conducted by a strong advocate of the system of small plots Noticing a luxuriant deep green spot on a patch of wheat which was meant to exhibit the effect of withholding nitrogen from it, I enquired how this green spot came, and I was told that the horse used in the ploughing had unluckily, chosen this particular spot for halting a moment and letting some highly nitrogenous manure fall upon the plot The plot was only one thousandth of an acre in extent, and it is not likely that the horse would have stopped similarly one thousand times while ploughing the entire acre, nor would a hare or rabbit, perhaps, nibble off from an acre just one thousand times as much as it had done from a small plot Besides this although small plots and "pot culture" may serve useful purposes in careful hands, I do not consider the results to be more than *indications* of what is likely to occur on the large scale and, until confirmed by field experiments under the natural conditions which present themselves in practical agriculture, they do not carry conviction with them It is not possible in "pot culture" to imitate the natural conditions, nor the influences of temperature, atmosphere, water, and soil which are at work in the open field.

462. The system of having duplicate plots in an experiment is a very wise one By this means an anomalous result may often be checked, and a satisfactory one be confirmed beyond doubt The provision of duplicate *unmanured* plots is even more important, for, by having these, one in one part of the experimental area, and one in another part, it is at once established whether the two unmanured plots substantially agree, in other words, whether the field is of even producing capacity, and, in this respect, suitable for experiment A great deal of trouble, and also money could, I am sure, be saved in experimental work, and far more satisfactory and conclusive, though less comprehensive, results be arrived at, were this system of duplicate plots, more especially of unmanured or "standard of reference" plots, more extensively used **Duplication of experimental plots**

O Blank experiment or unmanured plot.
N Native system or present manuring
P Proposed system or proposed manuring

S Space for possible extension of experiment

In either of these arrangements the carrying out of experiment *in duplicate* would ensure greater accuracy

An actual experiment and the explanation of its objects.

466. To give an instance of what I should consider a good experiment on the manurial treatment of a crop, I quote the following

from one of the Field Experiments of the Bath and West of England Agricultural Society, conducted in 1889 upon the barley crop

A	B	C	D	E	F
1½ cwt Nitrate of Soda 3 cwt Mineral Superphosphate. ½ cwt Muriate of Potash	1 cwt Sulphate of Ammonia 3 cwt Mineral Superphosphate ½ cwt Muriate of Potash	No Manure	1½ cwt Nitrate of Soda 3 cwt Mineral Superphosphate 3 cwt Common Salt	1½ cwt. Nitrate of Soda 3 cwt. Mineral Superphosphate	No Manure

Manures per acre

Upon examining the above scheme it will be seen that each plot is set to answer some definite question, thus —

1 The duplicate unmanured plots C and F give the natural unmanured produce of the soil, they tell whether the two parts of the field are of equal fertility, and hence whether the area is a suitable one for experimenting on Also, they give the basis for telling to what extent any of the manurial applications have been of benefit

2. The plots A and B tell whether nitrogen in the form of nitrate of soda, or of its equivalent in sulphate of ammonia, is the better, as the other manures comprising the mixture remain the same in each case, any difference would be traceable to one or other of the nitrogen-containing manures

3. The plots A and E, being alike in all respects except in the presence of potash salts in plot A, answer the question as to whether the addition of potash is beneficial or not.

4 The plots D and E being alike in all respects except in the presence of common salt in plot D, enable one to tell whether it is advisable to add salt to the manurial mixture

5. The plots A and D answer the question as to whether the dearer muriate of potash is better than the cheaper muriate of soda (common salt)

The above experiment was accordingly designed to bring out, with comparatively few plots, some very definite issues as to one particular point, *viz*, the manuring of the barley crop Further, it was tried simultaneously upon no less than 10 farms in different parts of England and on land where in each case the same crop (wheat) had preceded the barley Hence the results acquired special importance, and the experiment was an eminently satisfactory one

This concludes the consideration of the *Plan of Experiment* (commenced in paragraph 450).

Recording of details

467. *Recording of details* —During the progress of an experiment, details of what takes place, either in the ordinary course of cultivation, or else abnormally, should be recorded Thus, there should be notes made of the time at which the different field operations are carried out the preparation of the land, the time of manuring of sowing, of watering, of ripening, and of harvest and threshing, also, special occurrences such as those of heavy rainfall, continued drought, frost, blight, failure of plant, injury to plot, or other unusual feature, should be recorded These need not be made use of in a Report, else it may be overburdened with details, but they will certainly be very useful when the results obtained are compared and will aid in explaining the anomalies which so frequently present themselves in an experiment It may for instance, be established in this way that one part of an experimental plot is always of higher natural productive power than another, or that one part, by its situation or exposure, is more liable to damage of crop than another, all such irregularities should be taken into account, and they can only be found out by continuous watching of the experiment during its progress

The cost of cultivation

In the generality of experiments which would be carried on at Farms in India it is desirable that, so far as is possible, a comparative record of cost of cultivation should be preserved and also that, where manurial experiments are tried, the cost of the different manures and their application should be noted and clearly indicated It is well that each plot of an experiment should be distinctly labelled the label bearing a concise description both in English and in the vernacular of the treatment of the plot and the experiment of which it forms a part This should contain a statement of the cost of the manure, when any has been applied The importance of being able to see at a glance what is intended to be conveyed by an experiment is obvious In more distinctly scientific experiments the factor of cost does not enter, as the object is to test a theory or ascertain a truth whatever the cost and trouble involved may be But in experiments that are to bear directly upon actual practice the question of relative cost must not be excluded, and it becomes in the end the standard of appeal by which success is to be gauged At the same time the very circumstances of an Experimental Farm, the necessity of using hired labour, the extra cost of superintendence, the smallness of the plots, the additional expenses involved in separate cultivation, harvesting threshing, etc, prevent the statements of cost from being more than relative in character, and they do not represent actual costs

Statement of results

468 *Recording of results* —The recording of results should be, as far as possible, upon one uniform plan On looking over the Reports of Experimental Farms I find that in the statement of harvest returns the results are sometimes given in terms of increase or decrease per plot, as compared with the standard or unmanured, produce, sometimes in reference to difference per acre, and sometimes in terms of "percentage of difference" It would be much better if an uniform system were maintained throughout When

the Report is written in English, the most convenient standard of reference is the acre, and the weights should be taken in tons, cwts qrs and lbs or else in bushels There is no need to overburden a Report by stating the produce "per plot" What a particular plot produces is of no interest, it all depends upon what the size of the plot may happen to be If, however, the Reports be written in the vernacular, it is difficult to say which is the best plan to adopt, whether the local land measure and local weights, or whether "standard" ones, should be taken The different values attached to the *bigha* (land measure) and the *maund* (weight standard) in the various Provinces make the interpretation of results difficult. The Imperial *maund* of $82\frac{2}{7}$ lbs and the English *acre* would probably be the best understood "standard" The most natural plan at first sight would seem to be to use the local equivalents, but, seeing that the experiments are intended also for comparison with other parts, the best way would be to adopt, both in the English and the vernacular Reports, a double system of classification, the one local, the other general, and to put them side by side, with the necessary explanatory remarks as to the terms used.

In every case I think that increase or decrease should be stated in terms of "increase over standard plot," or "increase over unmanured plot," calculated upon (*a*) the acre, (*b*) the local *bigha*

In some Reports I have noticed that the attempt has been made to translate the results obtained into a money figure It may be naturally argued that, since the *money* gain is the final test, an experiment ought to show what this is The same feeling has been expressed with regard to English experiments but I may say that I have always upheld the sytem which I consider much better, *viz*, to state the *actual results* obtained, and to leave people to apply them to their individual and varying circumstances This has now, so far as England is concerned, been recognised as the best plan to follow, and I certainly advocate it for Experimental Farms in India The weights obtained at harvest are *actual* ones, and always remain good for purposes of reference or comparison, they are *facts* obtained The money values that one may assign to the items of produce are, however, *hypothetical*, and depend entirely upon the particular conditions that may prevail at the time they are made, and these conditions are liable to constant fluctuation Thus, what may be profitable under one set of circumstances may be converted into a loss under different surroundings, and so, while no one can dispute the actual weights obtained, the translation of them into money figures may involve erroneous assumptions or, at least, assumptions which have but limited and local application A single incident will elucidate this, it makes a considerable difference [illegible] to be put on produce is the [illegible] ce of it *consumed on the farm*, [illegible] market for a certain article in one district, though there may be in another, straw or green fodder may, near a town be highly profitable to s ll, while, at a distance from a town they may have only

Not des rable to g ve resu ts f money equiva lents

values. It is decidedly better, therefore, to state the results of ... to leave each person ... translate them into ... own district.

Examination and publication of results

469. *Examination and Publication of Results.*—The absence of a careful and critical examination of the results obtained has been one of the worst features of experimental work in India, and it is largely owing to this fact that it is so difficult when taking up any Farm Report, to do what may be called "make head or tail out of it." Something more is needed than merely to put down the results obtained, and to leave them in a tangled, unassorted, and often self-contradictory form Each result should be studied by itself first, and then in the light of other results, and it should only be allowed to be put on record after it has stood the test of ... ful- ... ten ... I ... the ... t is thoroughly bad in design, or when it has been damaged during progress, or when results obtained are evidently unsatisfactory or contradictory, I cannot see the force of putting out the experiment in detail, and of trying to draw conclusions from it, still less of burdening a Report with it, and of burying a good experiment amidst the records of bad ones. If desired, these may be put in a separate section, but the main Report should, I think, consist purely of the record of those experiments which have passed a critical examination, and which constitute a distinct advance in agricultural knowledge. The examination of the results, it is clear demands the employment of someone particularly qualified for the work, such a man, for instance, as the proposed "scientific adviser" would be. *As I said in the last chapter, this would, I* consider, constitute *one* of his chief duties. When results are obtained at any Experimental Farm they should be sent to the "scientific adviser" for his perusal and examination, and it should be for him to say which experiments are good and satisfactory, and to be placed on record, and which ones should first be tried over again, or should be omitted altogether. Of course, it would be quite understood that the "scientific adviser" would have no positive *veto* on the publ ... uld do would be to ... to Provincial Gov ... me time, however, ... bi- ... of India, it ... cognisance ... publication The issue of a general Report of this kind, not for one Province alone, but to combine the results of work in the several Provinces, would be very useful

Advantage of having a scientific adviser to examine results

I may be allowed to give, from my own experience, an instance of the useful supervision which such a "scientific adviser" could

exercise in the elimination of bad or imperfect results from good ones When asked to go over the Report of one of the Experimental Farms in India (the Farm being, I might add, certainly one of the best), I found drawn up at the end of the Report the results obtained for each experiment carried out. This had been done in the form recommended, after general conference with Agricultural Directors, by the Revenue and Agricultural Department in their Circular No. 143 A, 28th December 1885. In the column entitled

that I should have advised being placed on record. It would be far better to have, and far easier to follow, 11 good results that would bear criticism, than 35 results, many of which would not.

470. *Dissemination of Results.*—Upon the wide dissemination, in a clear and intelligible form, of the results of experiment depends much of their value and also popularity. There should not be too many Reports, and I should say that an annual one for each Farm or set of Farms is all that is needed. There is no call to have a Report for each season's crops. Dissemination of results

It is not possible to preserve complete uniformity in the returns, nor to lay down any precise plan for setting out the results. One experiment may require to be stated in one way, another in a different way. The most that can be done is to make these as alike as circumstances will permit, and to have one system of units adopted in one column at least, of the returns, so that they may be comparable at a glance, and not have to be calculated on to a common basis. Thus, to give results in one case in weight per acre, in another in weight per local *bigha*, at one time in *maunds* of 80 lbs., and in another in *maunds* of 40 lbs. [as in Gujarát (Bombay)], or in *maunds* of 28 lbs. (as in Coorg), is sure to cause confusion; and, therefore, the adoption in one column of a statement in terms of acres, and of tons cwts. qrs. lbs., or else of bushels, is necessary. This should be done in the English Report.

But I think it is very desirable that the Reports, or at least an abridged version of them, should be published in the vernacular also, and be disseminated in this form. It is mainly by such means that the work done at Experimental Farms can be po- Reports in the vernacular also

This leads me to observe that it would be a good plan to organise periodical visits to Experimental Farms, when, under the guidance of the Superintendent or Manager, visitors might be taken round to study the experiments, and any necessary explanations might be given on the spot. Periodical visits to Experimental Farms.

The publication and dissemination of the results of experiments should be undertaken by Government, and not be a direct charge upon the Farms.

The necessity of time and patience in experimental work

471 *Need of Time and Patience.*—If, in any agricultural work, time and patience are required, it is in that of experimental enquiry. A result is really not a good one ... -peated, and ... s only by ... -cumstanc ... a differer ... ment th ... be checked. I regard it as far more useful to get one sound result, the outcome of trial in different years, and under varied conditions, than to get fifty or even a hundred results which subsequent experiment might disprove I sincerely trust that, if a fresh impetus be given to experimental work by its re-establishment under a system such as I have proposed, Provincial and Imperial Departments of Agriculture will recognise that time and patience must be given, and that they should be content to wait for solid results, rather than that they should press those in charge to give returns which, unsupported, have but little value.

The financial test is not to be applied to Experimental Farms.

472. *Financial Test not criterion of success.*—I have already drawn (*see* paragraph 442) a clear distinction between Farms for *experimental* and those for *demonstration* purposes, and in the foregoing paragraphs I have mentioned, in passing, several circumstances which constitute differences betw... *cultu*... resul ... as th ... system ..., there may be many which prove unsuccessful, and perhaps only one a success, or else all alike may be found to be inferior to an existing practice. This is not money thrown ... gained in this way, ... er expense in the ... an Experimental ... -linarily incurred. When areas are small, as experimental plots generally are, and ... paths, ... e, and ... were ... ring, is ... time, when harvest ... different plots, and ... The entire economy ... is lost thereby. But it is in the matter of the employment of labour that a heavy burden rests upon Experimental Farms, and one which constitutes a great difference between the conditions of the Farm and those of the *raiyat's* small holding. The *raiyat* employs on his holding his own labour and that of his family, rarely using any hired labour, but on an Experimental Farm all must be hired labour,

and it is often very hard to procure this, nor is the labour always of the best, for a man does not work with the zeal that attaches to his own cultivation.

I have looked into the expenditure of Experimental Farms in India, and although there have been instances, especially in the case of Saidapet (Madras), of excessive expense incurred, I cannot say that I think that, on the whole, unreasonable sums have been spent on these Farms. The Bhadgaon (Bombay) Farm, comprising 1,200 acres, cost over and above receipts, in 1888, Rs. 990 only, and in 1889, Rs 743 only, exclusive of the superintendent's salary of Rs 3,000; the out of-pocket expenditure on the Nagpur (Central Provinces) Farm of 90 acres was, in 1888-89, Rs 3,744. These amounts do not read as large ones when compared with the 600*l* to 700*l*. a year which the Duke of Bedford gives for the support of the Woburn Experimental Farm of the Royal Agricultural Society of England, or the very much larger sum (probably about 3,000*l*.) annually expended by Sir John Lawes upon the world-known Rothamsted experiments In the United States of America there are 54 Experimental Stations, all of which are subsidised by the State, a sum of 3,000*l*. a year being paid to each

473 *Suitability of present Experiments* —I have no fault to find, as a rule, with the kind of experiments which have been conducted on Experimental Farms, and I would not suggest, therefore, any divergence from, or great extension of, what has been the aim in The kind of experiments suited to Experimental Farms

[illegible]

they are expensive chemical manures the object may be deprived of any practical outcome by the plan being bad The comparative produce of a crop under different systems of cultivation, different methods and times of sowing, different depths of ploughing, varying amounts of watering, etc., may form a fitting subject of enquiry, so, also, may the influence of the selection of seed and of change of seed, the out-turn of crops, the growing of new crops and new varieties of crops, the trial of new implements, etc The general line that experimental enquiry should take is to exhibit side by side a local practice or native system, be it of cultivation or of mechanical device, and another practised elsewhere in India or introduced from abroad, and then to see which one is the most successful in its results.

Then there are more extended but very necessary enquiries, such, for example, as that which Mr. Ozanne originated at Bhadgaon, on the feasibility and cost of establishing "Fuel Reserves," and, again, the more extensive one of the breeding of cattle.

474 *Seed-growing and Cattle-breeding at Farms* —But there is still another purpose which Experimental Farms, in the broad sense, can usefully fulfil, *viz*, that of becoming centres for the growth and distribution of pure and selected seeds, and for the Farms as seed-distributing centres and cattle-breeding Farms.

location of stud bulls, as well as, in some cases, for the breeding of cattle, and the distribution of bulls to the districts around Objects of this kind would have to be carried out on an area apart from the more specially experimental one, but they might very well, where opportunity serves, form adjuncts to an Experimental Farm, and could be worked concurrently with the latter under the one supervision This is actually done, so far as seed growing is concerned, at the Cawnpore Farm, whilst, at Bhadgaon, cattle-rearing is an important part of the work of the Farm Reference to these has already been made in Chapter XIII, paragraph 310, and in Chapter XI, paragraph 257 At Cawnpore a separate area of 12 acres attached to the Experimental Farm, is utilised for growing cereals for sale as seed, and another area of over 50 acres is kept as a fruit and vegetable garden

It is certainly one of the most useful functions that a Government Farm can serve, to act as a seed-distributing centre, and where conditions are favourable, as a cattle-breeding farm also, and both these objects might often be carried on concurrently with the more special work of experiment

Demonstration Farms

475. *Demonstration Farms*—There are other Farms which, [illegible] are so closely allied to Ex- [illegible] suitably for treatment here [illegible] s," to which reference has already been made The purpose of these Farms would be to show, on a practical scale, the result of what has, by experimental trial on the smaller scale proved to be beneficial By means of them the advantage of a better mode of cultivation, of a new crop, or of an improved implement, could be set forth, and be brought home to the cultivators It is not enough to have an Experimental Farm alone, but along with it should go a Farm for demonstration purposes In this respect there is a decided difference between India and England In England the farmers are the demonstr [illegible] but it is not so in I [illegible] between the Experi [illegible] h a Demonstration [illegible] of bringing to the [illegible] cesses which have been proved experimentally to be better than his own In this way the superior cultivation of one locality may be transferred to another where inferior cultivation prevails

A Demonstration Farm should be expected to pay its expenses, inasmuch as it is intended to show what is the most profitable practice At the same time a certain allowance must be made for the extra expense of hired labour, against which, on the other hand, must be put a fair subsistence amount for the *raiyat* and his family, who would otherwise be occupying the land

Experiments and demonstrations upon private lands.

476 *Private Farms*—In some cases it may be possible to induce cultivating landowners to undertake *experiments on their* own land, or it may be advisable, instead of having a separate Demonstration Farm, to have the demonstration carried out upon

a field in the actual occupancy of a tenant. If the latter be done, it may be necessary to guarantee the tenant against any possible loss arising from his having undertaken the trial, and to award him compensation for any loss of crop resulting from his having done so.

Where a private individual undertakes an experiment in this way, or gives his land for demonstration purposes, the portion devoted to this object should be under the notice and control of the Director of Agriculture, or of the expert assistants acting under him.

Judging from the number of instances in which landowners have already given part of their land for experimental purposes, alike in Bengal, the North West Provinces, Bombay, and Madras, it is not likely that there will be any difficulty in obtaining whatever land is required.

In the North-West Provinces there are no less than six private farms used either as Experimental or Demonstration Farms. One of the largest is at Meerut, and belongs to Rai Bahadur Debi Singh; another near Cawnpore consists of 165 acres, and is conducted by Mr. Lachman Parshád, Personal Assistant to the Director of the Agricultural Department, North-West Provinces.

It has been urged with much weight that Court of Wards' Estates could well be made Demonstration Farms, for exhibiting what is found successful at an Experimental Farm, and of thus bringing the results to the cultivators' doors. This, it seems to me, might very well be done.

Another class of farm on which experiments, both with crops and with implements, might be conducted, is comprised in the farms attached to Government Breeding Studs, such as those at Saharanpur, Hapur (near Meerut), Hissar, and elsewhere.

Individual Experimental Farms

477. It now remains for me to briefly review the different Experimental Farms which I visited. I do not purpose to go exhaustively into a detailed account of the different experiments then in progress, still less into the past history of the several Farms What I wish to do is to remark generally upon the more prominent points that struck me when I went to each Farm

Cawnpore Farm (North-West Provinces)

478. *North-West Provinces.*—Cawnpore Farm:

The first that I will take is the Cawnpore Farm, partly because, after the Saidapet Farm (now practically abolished), it is one of the earliest Experimental Farms, and partly because it is the one which I visited most frequently, and followed most particularly Indeed, I made it a point to watch here the different crops at all the various seasons of the year

Like many of the [illegible] representations made by those who carry [illegible] ally known as the "model farm" [illegible] aspires to be a "model," nor yet is [illegible] of the term It is in reality an [illegible] to which is added a certain area for the purpose of growing selected seed. As such, I am

ready to say that I consider that the Cawnpore Farm fulfils well the purpose of its establishment It is a well conducted Experimental Station, in a convenient position and with a suitable soil, and though faults in detail may be found with it the general conception and working of it are thoroughly good The Cawnpore Farm is, I think, more like what an Indian Experimental Station should be than any other I met with in the country although its younger rival, Nagpur, bids fair in some respects to threaten its leading position The good work done at the Cawnpore Farm is due, in great measure to the succession of good men who have had the oversight or the actual charge of it. From its inception in 1874 through the energy and interest shown by Sir John Strachey, it can claim to have had in the past the help of such men as Sir Edward Buck, Mr J B Fuller, and Colonel Pitcher, while, at the time of my visit, under the charge of Mir Muhammad Husain it continued to do good and useful work. In fact I was much pleased with the Cawnpore Farm, and was not prepared to find in India anything which so nearly came up to my idea of what an Experimental Station should be It is well to note, after the disparaging remarks that I heard about this and other Farms, that I found the crops to be a great deal better than those on the adjoining fields belonging to the cultivators around On one side a wire fence divided the fields of the Farm from those of the cultivators, and the superiority of the Farm's crops was most marked

One way in which the Farm shows that its design has suffered is, that it bears the marks of more hands than one having been at work An experiment has suggested itself to one Director or Assistant Director, and has been carried on for a time, and then been dropped or modified by another Director This is the fault of a non-continuous system of direction or supervision A Report upon the operations at the Farm is now issued once every year, though formerly a separate Report was given for each season

The Farm was started in 1874, and comprises 42 acres of experimental farming and 65 acres of fruit and vegetable gardening Included in the latter are 12 acres put in cereals for the purposes of growing seed for distribution. Attached to the Farm is also a workshop where ploughs, pumps, and other implements are made and sold, and where a collection of implements, both of Native and of European make, are exhibited.

The main objects aimed at by the Farm are —

1 To try new methods of cultivation, and to compare them with indigenous ones
2 To ascertain the probable out turn of crops for each year
3 To try new crops and new varieties of crops
4 To ascertain the effect of manures upon particular crops, and to try the value of new manurial agents
5 To test new implements.
6 To grow and distribute selected seed
7 To make and sell improved implements.

The farm is very well placed, it is ready of access from Cawnpore, and yet is in the midst of cultivation, the soil is very typical of a large area in these Provinces and the position of the experimental field is all that could be wished The cultivation is thoroughly done and I am fully satisfied as to the care that is taken to ensure accuracy in all details I was present, in April 1890 during the threshing of the cold season (*rabi*) harvest, and nothing could have been more carefully carried out In fact, I would be inclined to say that it erred rather on the side of over-refinement

Without going into details of the many experiments which I saw in progress I will just pass a comment here and there as it may suggest itself In what is termed the 'Standard Series Manure Experiment" a cold season (*rabi*) crop, *viz*, wheat, and a rainy season (*kharif*) crop, *viz*, maize, are grown year after year, the same manures being applied each time This experiment has the great advantage of being carried out in duplicate, and the plots, which are 13 in number, are of fair size, *viz*., 400 square

yards each The manures tried are cow-dung, cow dung ashes, sheep dung, poudrette (night-soil), saltpetre, gypsum, bone-dust, and bone superphosphate The only one that seems out of place is the bone-superphosphate, [illegible]

thus —

Plot	Manure per Acre and Cost	PRODUCE PER ACRE			
		DRESSED CORN			Straw Chaff etc
		Weight	Bushels	Weight per Bushel	

For reasons I have given before, I do not approve of assuming, as is done at Cawnpore, a money value for the crop, but I would leave each person to take the figures obtained and apply them to his own case

In a miscellaneous manure series on wheat, manures such as brick-kiln refuse,

experiment

Miscellaneous manures used on maize comprise woollen refuse, sheep-dung, cow-dung, poudrette, horse dung, pigs' droppings, and saltpetre Woollen *refuse gives the best return by far*, but, as *I said earlier in this chapter, it is* not a manure which the *raiyat* can obtain, and the Farm uses up all of the local production, so the information from the experiment is not of any practical value It is very doubtful, too, whether horse-dung and pigs'-droppings as *separate* manures have a practical value either There is no duplicate unmanured plot here

A series of *green-manuring* experiments on wheat is designed to show the value of indigo and hemp as preparatory crops, and when ploughed in as manure, also of indigo refuse (*seet*), and of the refuse water from indigo and hemp manufacture So far as the previous cropping and also ploughing-in go, [illegible]

The last of the permanent series of experiments, the foregoing being all ... at with ... his is a ... to me ... would ... rrangs

After these permanent experiments follow a number of others of more or less temporary duration, upon which I need not dwell long

Maize is grown on the American plan, as against the indigenous system, also the difference between early and late sowing is tested The early and late sowing of cotton, and the out-turn of 11 different varieties of imported cotton seed, are tried, and both form useful experiments, though the plots on which the varieties of cotton are grown are somewhat too small to test the question of out-turn thoroughly

With sugar-cane, different methods of sowing including indigenous ones are compared, the yield of different varieties of cane, and the value of cane left for a second year, are tested

Experiments upon indigo include trials of the use of gypsum as a manure, and the difference of early and late sowings

Manurial experiments upon wheat are made with cotton-seed cake and mustard cake, as against ordinary cow-dung and dung made by animals fed with cotton seed.

Then there are further manurial trials with kainit and woollen refuse on wheat, but the value of these is very doubtful, for kainit would have to be ...

Better than the last is an experiment on different varieties of wheat, the outcome of which is, that a great deal of Muzaffarnagar wheat (soft white) is grown for distribution, and also Sindhi, a hard white wheat, which grows very high and is a late variety

Varieties of barley have also been tried, and a white huskless variety has been very successful.

Lastly, manurial experiments have been made with gypsum upon leguminous crops, and with poudrette, woollen refuse, kainit gypsum, and castor cake upon potatoes the latter manure being as before, open to the objection attaching to woollen refuse and kainit, the experiments are satisfactory in most other respects

... whole, a very ... , but, so far ... main points ... with an existing practice

In addition to the above, there have been attempts from time to time to introduce new crops, such as Guinea grass (*Panicum jumentorum*) for fodder, and the variety of *Sorghum saccharatum* known as sorgho

The general out-turn of crops has been estimated from plots grown on the Farm, in order to check the forecasts made for the Provinces But this is not satisfactory, for so much depends upon whether the land has been watered and manured or not; at Cawnpore, cattle manure is used, and canal irrigation is available The general out-turn of wheat in 1888 89 was about 22 bushels per acre over the Farm

Implements have been extensively tried at the Farm, including different kinds of sugar mills, sugar-evaporating machines, ploughs and pumps These have been referred to in Chapter XII, paragraph 266. The extensive seed distribution carried on has been spoken of in Chapter XIII, paragraph 310.

Another useful purpose which the Farm has served is, in having been the training ground of a number of apprentices who have subsequently gone out to other farms

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The Farm Report (I refer to that of 1888-89) has a good and clear description of the experiments and their aim I would point out that its chief fault is the complication of the results by the giving of so many columns in the tabular statements Again, it would be well to adopt greater uniformity of nomenclature, for instance, in several cases, *bighas* and acres are mentioned together, and in other cases *bighas* and square yards

The danger, as regards the future is that owing to the large number of *manurial* experiments, the land will be affected so unevenly that it will be a difficult matter to find space for fresh experiments when needed, or, what is worse, the results of the trials will not be accurate, owing to the difference in the previous treatment of the plots composing them. I hardly think that *manurial* experiments are the most important ones in India, for the difficulty is to get manure of any kind whatever I would rather see more space given to experiments in methods of cultivation There should also be a reserve of land kept over, treated and cropped each year much alike, this would serve for the extension of experiments as required I should also like to see considerably more duplication of experiment. It is not so important to get a large number of results as to make sure that those given are correct and this can only be verified by repeating them, not only on the same spot but on fresh land, and in a succession of years

It seems to me that the Farm might will be made use of as one at which stud bulls could be located for the breeding of good farm cattle There are great complaints in the neighbourhood that the Brahmani bulls are getting scarcer and scarcer, and the Farm might in this way supply the deficiency

479. *Gardens at Saharanpur and Lucknow*

Gardens at Saharanpur an Lucknow

Not altogether of the nature of Experimental Farms, though in their origin intended to be more or less so are the gardens at Saharanpur and Lucknow Formerly, experiments were carried on at these, but little of this work now remains the gardens being worked on a commercial basis and being really only used for the sale of plants and seeds, the supply of drugs to Government stores, and for the training of gardeners.

Some experiments have been tried on the acclimatisation of English varieties of wheat, on the growing of the date palm (*Phoenix dactylifera*) and other plants but now there is hardly any of this work done, and though they form pleasant recreation grounds, and do good in providing plants and seeds for sale, the gardens can hardly be classed as Experimental Farms, but only as Nurseries, which, in India, take the place of those of the florists and seedsmen of England

480. *Central Provinces*—Nagpur Farm

Nagpur Farm (Central Provinces).

This is one of the more recently formed Stations, it having been started on its present plan in 1883, although previously to this a large "model farm" as it was called, of nearly 400 acres had existed The present Farm is about 90 acres in extent 67 acres being experimental and it is based upon the model of the Cawnpore Farm this being accounted for by the transference of Mr J. D Fuller from the North-West to the Central Provinces about that time The out of pocket expenditure on the Farm in 1888 89 was Rs. 3 744, and in 1889 90, Rs 6,801, this latter including the

... before ... ned in The Farm is well placed,
... ntly situated as regards the town
... ts are of a fair size, and the soil is
... nd in the Provinces If I took any
... ground of the soil being rather too
... he case of India it is better however
... the district than to have soil more

The Farm generally, and the experimental plots, were evidently well and carefully cultivated the whole was in good order, and a close examination of the Reports leads me to conclude that the results are accurately and faithfully recorded.

The present Manager is Mr Mahalaxmivala a careful and competent man who takes much interest in the work of the Farm

This Farm and the Cawnpore Farm more nearly approach what an Experimental Station should be than any of the other Farms which I saw in India

Cotton is the chief crop of the Central Provinces and so it is natural that experiments should be largely concerned with it

The first series is a manurial one upon cotton Ordinary cattle-manure, poudrette (night soil), and bone dust are tried There are several duplicate unmanured plots but in the statement of results neither the quantity of manure (in 1888 89) nor its cost per acre are given On the other hand, details such as the area of the field the serial number of experiment, the number of hand-weedings and the number of bullock hoeings might well be omitted The plan of the experiment is good and (I refer to the 1888 89 Report) the results are consistent, and would show the soil to be suitable for experiment

The next series is termed " green soiling on cotton " hemp being the crop used as manure By ... operly meant that a crop is ... What was done here was ... crop preparatory to puttin ... In this case, again the ... re to plots The results of this experiment are not conclusive, and their publication might with advantage have been deferred.

Trials were made with cotton seed prepared for sowing by steeping it in sulphuric acid to remove the wool as against the native practice of steeping it in cow dung and water The same was done in 1886 87, the results being then unsatisfactory, but in 1889 90 they seemed to give some evidence of benefit accruing from the sulphuric acid treatment Further confirmation is clearly needed before more can be said

After this follows a manurial experiment upon *til* (*Sesamum indicum*) The experiment, however, hardly starts on a fair basis for these same plots, with the same manures each year, had been previously used for a permanent series with wheat Consequently the plots did not begin level, and the ... on the *til* crop alone So
... manures likely to benefit
... d and not that upon which
... ue of years previously I should
... suitable experimental crop. Great
... I believe, in great measure, to the
... if the crop In 1889 89 bone-dust
... her used alone, and in 1889-90
... attle dung alone It is possible
... not believe in the possibility of
... as no duplicate unmanured plot

In another case *sorgho* (*Sorghum saccharatum*) was grown for the purpose of making sugar, but very ...

Experiments on silage ... and Guinea grass (*Panicum jumentor* ... the losses,

amounting to 33 per cent in one case and 49 per cent. in another, between the weights of green stuff put in and the silage taken out are far too high. Where silage is to be made every year, I would certainly advocate brick or masonry silos in preference to those merely dug in the soil, which have only earthen sides and bottom.

The out-turn of crops is gathered from other plots on which some 12 different crops are grown So much depends, however, on the soil and the manuring given that the results are but of limited value

With cold season (*rabi*) crops trials have been made on the effect of embanking land in the case of wheat and linseed The results are not encouraging, but the native method had not been properly studied previous to the commencement of the trial

Green-manuring, or green soiling, as it is inaccurately called in the Report, has been carried out with wheat and linseed, and in another part different manures, such as bone-dust, gypsum, dung, and hemp, have been tried In neither case are the results properly comparable

The most satisfactory series has been the permanent one on the manuring of wheat, this crop having been grown year after year, with the same manures each year, these being, all of them, such as might well be used for wheat The existence of this experiment in duplicate adds much to its value What is wanting in the statement is the cost of the manures The duplicate experiments agree very fairly with one another, several distinct issues are brought out, and the influence of season is checked by the repetition year after year, altogether, the experiment is a very good one

The averages are also given for the past five years, and the following interesting comparisons with the Woburn (England) experiments for 10 years may be drawn —

—	—	Manures per Acre	Produce of Wheat Bushels per Acre	Produce of Straw Cwt per Acre
1	Nagpur	No manure	13	9
	Woburn	ditto	17	17
2	Nagpur	Saltpetre 240 lbs	19½	14
	Woburn	Nitrate of soda 275 lbs.	24	25
3	Nagpur	Cattle-dung 6 tons	14½	—
	Woburn	Farmyard manure 4 tons	21	—

In the returns no attempt has been made (and I think wisely) to assign any money value to the different yields I do not like, however, the method of returning the produce as "percentage of increase over produce of unmanured plot;" it would be much better to simply give it as "increase per acre over unmanured produce

An experiment more of the nature of scientific enquiry is that termed "the [illegible] chloride, [illegible] ed on one [illegible] and the [illegible] the plant requires most.

In addition, trials have been made with different sugar-mills, different varieties of wheat have been grown, selected cotton seed has been distributed to cultivators, and a limited number of new implements have been sold

But one of the chief functions which the Farm performs is that of being the training and instruction ground for the Agricultural Class, of which further mention will be made in the next chapter.

The Nagpur Farm has not had the advantage which the Cawnpore Farm enjoys of being old enough for the character or the qualities of the land to be sufficiently brought out, and there is still a good deal to be learnt about

it before experimental work can be fully satisfactory. Besides this, the soil does not appear to me so well suited as the Cawnpore one to the purposes of experiment. In general, the plan set forth is good, and the details are accurately carried out, but the results require a good deal of careful sifting before it can with any safety be stated that a definite conclusion is warranted.

At the close of the Report is a summary or "comparative record" of results. This is done in accordance with the recommendations of the Agricultural Conference which met in *Calcutta* in 1881 but this summary is I think, both useless and misleading. The same result is made use of over and over again to institute comparisons, even where the conditions have been quite diverse, and the consequence is, that if a conclusion be faulty from any reason, it is brought in time after time, and may lead to other faulty conclusions being drawn, even where the immediate premises are good.

Bombay Farms 481. *Bombay Farms.*—The Bombay Government owns two Experimental Farms, one at Poona, the other at Bhadgaon, near Pachora, in Khándesh. But neither is experimental in the full sense, the Poona Farm being used mostly for educational purposes in connection with the agricultural branch of the Poona College of Science, and the Bhadgaon Farm approaching more to a "Model Farm" than any other in India, and being also devoted largely to the breeding of cattle.

The Farms are the outcome of the movement in 1869 to establish "Cotton Farms" in India. At the time of the American Civil War attention was turned to India as a main source of the future cotton supply, and, accordingly, "Cotton Farms" were established throughout that country under the charge of men sent out from England, but who, as a rule, were really nothing better than gardeners. After the Civil War was over, the cotton trade returned to its normal state, and the Farms then became Model and Experimental Farms, and were transferred in 1873 from the Cotton Commissioners to the Provincial Governments. In a few cases the "cotton farmers" brought over were retained as Managers of the Farms, but in most cases they were found unfitted for the duties.

Bhadgaon Farm 482. *The Bhadgaon Farm*

comprises 1,200 acres, of which only 65 acres are experimental, and 600 [illegible] the remainder being grazing and [illegible] was Rs 990, not including the [illegible] 90 it was Rs 3,743, including the [illegible] *esents the net cost to Government.*

It is not an *Experimental Station* in the sense that Cawnpore and Nagpur are but is really a farm where improved cultivation is attempted, where cattle are bred, and where, now and again, a few experiments are tried over a limited area.

Regarding it simply as a Fa[illegible] t is carried on [illegible] *Mehta*, the [illegible] *is a capable and thoroughly* p[illegible] interest and *displays much assiduity in carrying* o[illegible] *work*. He is one who can and does turn his hand to anything that is required on the Farm, and is himself no mean "cattle doctor." I was greatly pleased with the Bhadgaon Farm as a general though not Experimental Farm, and I think that it is most creditable that the expense incurred by it is

so small as it is The amount spent is really very trifling and the advantages it is likely to afford in the future as a training ground, when agricultural

prising to me that the expenses are so nearly met, for it has to be remembered that the produce of the different fields is all gathered separately, and thrashed and weighed separately many records have to be kept, and hired labour has to be employed If the crops could be all put together, and thrashed and stored at once, the Farm would be able to pay its expenses quite well, but then it would be a pity to lose the information that can be obtained here Seeing this, I do not think that the Superintendent ought to be needlessly tied down by considerations of cost It would be much better to devote annually to the Farm a certain sum which past experience has shown it to require and so long as the Farm is conducted as at present, the Bombay Government may be assured that the

I need not say more than I have given in Chapter XI (paragraph 255) about the cattle breeding operations at Bhadgaon in order to show that the Farm is doing good. The readiness of the people to buy the young

It is to stock breeding
articularly devoted and
orty acres of land have
s it is not intended to
y properly been sown all

made without difficulty, and since I left India the experiment has been tried to make a "stack silo" in the open, instead of digging a pit in the ground

(Arab) is also located here, but is not much appreciated as yet.

A great fault of the Farm is its isolation, it is hard to get to and consequently cannot be easily visited Half-a-day's journey has to be taken from the nearest station, and several rivers have to be crossed or forded

The Farm is unnecessarily large, and is not suited as an experimental area. The distance from any large town makes the sale of the produce not so remunerative as it would otherwise be. In many ways the cultivation is superior, and I noticed here an attempt made to preserve the cattle manure. A large quantity is made and kept in a pit but it might be improved in quality if better stored, turned over occasionally, and then heaped together more closely; it was allowed to lie too loosely and to become too dry; a large amount of straw and stalks, which might quite well have been used for litter, was left in a dry state, and not mixed up with the cattle droppings and so allowed to decay, while the urine from the sheds was wasted ... a considerable extent, and during the rainy season ... n water from the ... ngs of the ... dry sta ... urine ... might p ...

There ... that the Bhadgaon Farm might usefully fulfil. It would be a capital place at which to send into residence for a time the agricultural students of the Poona College. Here they might see carried out on a practical scale what they had learned theoretically, and they might do the actual farm work themselves at Bhadgaon. A practical class of this kind, following upon the instruction given at Poona, would be of great benefit.

The Bhadgaon Farm might also be utilised as a place to which apprentices might come and receive a practical training before going out to act as managers of estates, or to look after their own landed property.

Poona Farm

483. *The Poona Farm,*

as I have said, is not an Experimental but rather an Educational Farm. Different crops are grown, and their yield is estimated, a few cattle ... kept ... nd ...

Silage has been made here, but no light is thrown on what the cost has been or whether the system is remunerative. The manure from the cattle is very badly stored, the urine is almost entirely wasted, and the manure heap is little more than a dry rubbish heap. A great improvement in this respect might be made, more especially at a place where students come for instruction.

In one case a comparison has been tried between Khandesh *judr* (*Sorghum vulgare*) and the local kind grown, but, as the previous crop was partly sugar-cane and partly gram (pulse), the plots did not start under level conditions.

As a place where the students of the College can come and see different crops grown and become familiar with them, and with the outlines of farm operations, the Poona Farm has an educational value; but, inasmuch as the students do not work on it themselves, it would seem to me very desirable that during their course they should be sent to the Bhadgaon Farm, where they could see the work carried out on a practical scale. It should also be mentioned that at Poona Mr. Ozanne has got together a very complete collection of native agricultural implements.

There used to be another Farm at Hyderabad, in Sind, but there is no longer a Government Farm, it having been given up in 1889. The experiments here were of no value.

Nadiad Farm

484. At *Nadiad, in Gujarát (Bombay),*

there is a Farm of 12 acres, inaugurated in 1878, and kept up by the Agricultural Association. It is made use of in connection with the Agri-

cultural Class attached to the High School. The soil is a rich red garden loam, and very deep

Manurial experiments form the principal work. These are upon *rági* (millet), *tur* (pulse), and *judr* (millet), also an extensive series upon tobacco, to which reference has been made in paragraph 368 Different varieties of cotton, American and indigenous, as also of the castor oil plant, are tried Male buffaloes are used in ploughing a practice not locally adopted, but which it is sought to introduce, and iron ploughs are also employed There is a museum attached to the Farm, containing specimens of cotton, cereals, etc, and in the town is a seed store maintained by the Association, where pure seed can be got by cultivators The Farm is given rent free by Government, so long as it is available for the Agricultural class, the yearly expenses, amounting to Rs. 400, are more than covered by the out turn. The Association hold a Cattle Show biennially at Nadiad

485. In the *Native State of Baroda* Farms in Baroda.

experimental work bids fair to make a good beginning for not only does His Highness the Gaekwar take a great interest in agriculture, but he has also secured the services of Mr Middleton, formerly a distinguished agricultural student at home, as Professor of Agriculture at the Baroda College In company with Mr Ozanne and Mr Middleton I went over the proposed Experimental Farm, and I need but say that I am sure that what Mr. Middleton does he will do well, and his presence in India will be a distinct gain to agriculture in that country As the experimental area had not been taken up when I was there, it is of no use for me to refer further to it except to say that I look to much good resulting from it, as Mr Middleton is, perhaps, the first man who has come out to India who has combined a practical acquaintance of agriculture with good general knowledge of agricultural science

When at Baroda I also visited another Experimental Farm, as it was termed carried on by Mr Kacherao Jadnava an ex student of the Royal Agricultural College, Cirencester An Agricultural Class is supposed to come here for practical instruction, and at the time of my visit I saw the students working away on plots a few yards square, which had about a dozen plants of some crop growing on them All looked pretty enough, but I could not say more Attached to the Farm was a wonderful collection of implements gathered I should say from all parts of the world, and at great cost too, but with utter disregard to the conditions of Indian agriculture Here, for example, was a huge waggon from Germany, used in that country for bringing brewers' grains and beet root pulp and distilleries, and requiring perhaps, some six horses to draw it! Here, too, were huge iron seed drills, heavy iron ploughs manure distributors and seed-barrows ... so had a ... set of ... le sum, ... ause of agricultural improvement

486 Fruit Farms

In addition to the Farms in the Bombay Presidency here mentioned, there are fruit gardens at Ganesh Khind, near Poona, comprising 60 acres, and devoted to the growing of mangoes and more especially to the propagation and sale of grafted mango trees This culture is also carried on to a more limited extent on a part of the Poona Farm A large quantity of grass is cut green from off the Ganesh Khind plantations

487. The plans for future experimental work in Bombay comprise the establishment of a Stock and Dairy Farm at Alegaon and the starting of new Experimental Farms of small extent in five or six different districts of the Presidency, notably the Southern Future plans in Bombay

Mahratta country, the Konkan and Gujarát The object of these is to test in one locality the results obtained at others, and so to establish their value in relation to the different conditions and soils that occur throughout the Presidency. With the view of supervising these, a European Superintendent of Farms has been appointed, whose special work it will be to look after the Farms and the experiments at them Against these proposals I have no decided objections to urge, so long as it can be clearly established that a distinct need exists for the Farms, but on this I can hardly give an opinion The wants of one district will not be those of another, and crops and methods of cultivation will differ too If arrangements can be made for efficient supervision, and if, as I have said, a *primâ facie* case can be made out for the establishment of a Farm or for the testing of any particular local practice, then there is the warrant for its existence. But unless the object be clear and unmistakable, and the necessity for experimenting in a particular district be shown, I do not regard the starting of fresh Farms as advisable. Something more is needed than a "general idea" as to the usefulness of an Experimental Farm

Madras Farms Saidapet

488 *Madras*—Saidapet Farm. The earliest of all the Experimental Farms was Saidapet, established in 1865 It is also the one on which the greatest attempts have been made to introduce new practices and new implements to the notice of the Indian cultivator The past expenditure on the Farm has been considerable, and it has now been finally abandoned as an Experimental Station. From 1871 to 1887 it was under the direction of Mr. W. R Robertson, and was supplemented in 1876 by the starting of an Agricultural College It is not for me here to go into the past history of the Farm, nor to discuss at length the steps which have led to its abandonment It is enough to say, in the words of the Director of [illegible]

Undoubtedly this failure to bring itself into sufficiently close communication with native agriculturists has had much to do with the result, but there have been other causes too, prominent among which has been the constant change of policy adopted by the Madras Government towards the Farm, and the refusal to supply it with the necessary funds, yet another has been the unsuitableness of the spot chosen for the Farm It is, as I have described it elsewhere, little more than a sand hill, and ought never to have been selected as the site of a Farm It is too small for stock-breeding, and [illegible] g It may serve in some ways [illegible] of agricultural students at the [illegible] ore At the time of my visit experimental work had been almost entirely given up From being partly under the Agricultural and partly under the Educational Department, the College is now to be separated from the Farm, and to be placed, along with its Principal, under the Educational Department The 300 acres of which the Farm originally consisted have now been reduced to 60 acres and will simply serve the purpose of illustrating the growth of different crops

The cattle I saw at the Farm were 12 Nellore cows and 16 Nellore and Aden bulls, and they were very good indeed The bulls are kept for stud purposes, and their services are available, at a low fee, for stock belonging to cultivators, but they are not much made use of. I have mentioned previously an experiment carried out on sheep, four being fed on earth-nut cake with other food, and four without the cake, but I pointed out also how inadequate the number of animals was for the purpose (*see* paragraph 458)

There is, however, one point that the Saidapet Farm has done very considerable good in showing, *viz*, that cattle can be kept perfectly well on the 'box' system, that is, with litter under them, and that the manure

No Experimental Farm has worked harder than Saidapet in trying to introduce iron ploughs, and here and there (more especially where there has been a considerable area to till, so that time has been a matter of importance) some few iron ploughs are used by landed proprietors, but they have hardly come down to the small cultivators yet, though much ingenuity has been expended on simplifying them, and on decreasing their cost.

489. Madura Farm.

I visited at Madura what was formerly the Experimental Farm of the Madura Farmers' Club, but which has now been given up, except so far as the dairy part of the Farm is concerned It comprises 30 acres and was started in 1883, under the care of a student from the Saidapet College

er-lifts, with s not appear lost in the this part of ws in m lk k, and they ield of milk

490 In September 1889 an Agricultural Committee was appointed to enquire into the operations of the Madras Agricultural Department, and the Report of this Committee was presented to, and considered at, the Agricultural Conference at Simla, in October 1890 As regards Experimental Farms in Madras the Report of Madras Agricultural Committee 1889

dicates that the chief reasons of failure have been the absence of an organised Department, an insufficient staff, imperfect supervision, and the want of knowledge of indigenous practices and conditions The mistake made at the beginning was that the *raiyat* wanted teaching, and that all his practices and implements would have to be altered and that the "Model Farm" was to teach him his business. In place of this the Agricultural Committee now recommend the abandonment of the idea of teaching the *raiyat*, until, after careful

enquiry, more is known as to the native practices and conditions. The Committee also advise the inauguration of experiments under the control of trained agriculturists. It is now proposed to have experiment and demonstration carried on at some five or six Farms, each not exceeding 30 acres in extent, in different parts of the Presidency. Each is to be a combined Agricultural School and Farm, or Farm School. The Farms are to be under the management of the head master of the school, who is to be a graduate of Saidapet College, and acquainted with agricultural practice. Meantime the Saidapet College and Farm are to be retained as training grounds for future teachers.

I have already thoroughly endorsed the recommendations of the Committee as to the necessity of abandoning the attempt to teach the *raiyat* until more is known, through careful enquiry, of what his practices really are, and the conditions under which he pursues them. I am not so certain, however, about the advisability of starting at once some five or six different Farms, partly experimental, partly educational, or *demonstrative*, in different parts of the country. If there be efficient and sufficient supervision for them, the plan may be adopted with benefit, if kept to a limited scale, and if the sites be suitably chosen. It is said that there are qualified graduates who have passed out of Saidapet College, and that they could be utilised as Superintendents of the Farms. Of their qualifications for such posts I can hardly speak, but I cannot help noting that the Government Order (No 515, Revenue, 4th July 1890), which, in paragraph 12, approves of the plan recommended by the Agricultural Committee, also says, in paragraph 11, "special "instruction in agriculture, however, is almost non-existent owing to "the want of men competent to give it." I should be afraid of the former blunder being repeated, and I think that it would be better only to establish a Farm which is at all experimental in character where there is a positive call for it, and where there is fully competent superintendence. Unless this be the case, Agricultural Education would be better helped by Farms of a purely illustrative character.

Nor can I agree with the recommendation to extend the Saidapet Farm, and to make it more complete and practical. The Saidapet Farm, by reason of its soil and situation, will never be a suitable place for illustrating agricultural operations, still less for trying experiments. And this I say not merely from what I have read or heard, but from what I have seen myself. If asked to start an Experimental Farm there I should, if possible, decline at once to do so, for the place neither is, nor can be, at any reasonable cost, made suitable. A part of it is even blowing sand. I do not at all agree with some remarks made by Mr Nicholson in his note to the Agricultural Committee's Report, to the effect that, even if the soil be poor, as described, it should be possible to improve it, and to show what the *raiyat* might then do with it, and that if the Farm cannot show this, it has no right to be called a "Model Farm." It must be remembered that there are soils in England as well as in India on which any expenditure on improvement is simply money thrown away, there may be soil that is not worth reclaiming or

improving, at least under existing circumstances, the influence of manures and other means of bettering soils depend, for their efficiency, on the *responsiveness* of the soil, and what may be retained on the one may pass through the other, and so be wasted, on certain lands of good productive power it may pay perfectly well to use, say, 2 cwt, or even as much as 4 cwt, per acre of nitrate of soda, costing from 20s to 40s an acre alone, whereas on another soil even ½ cwt of nitrate of soda an acre would be thrown away. Again, a great deal depends upon what the crops may be, and what the market conditions are An English farmer would not grudge to spend large sums in manure if he could get thereby, say, an early crop of potatoes, but if they came a fortnight later, a loss instead of a gain might result, though the potatoes might in either case be equally good in themselves So, too, with [illegible] kind, it will not pay to go [illegible] favourable soil, situation, [illegible] kind of barley can be grown, a good return for outlay is ensured I have laid it down as a condition of success in experiment that the soil must be fairly responsive to manure and cultivation, and if one has to do [illegible] the improve-me[illegible] unworthy to [illegible] best to do with such land, if it has to be cultivated, is, not to see *how much* can be sunk in it in hope of getting benefit one day, but *how little* need be expended upon it. I maintain that the chief end of experiment is to see how land that is fairly productive can be got to produce more, and not how land that is not fit for cultivation can be brought under the influence of methods and practices applied in England and elsewhere to the increasing of the crop-return There may be circumstances where the restoration of deteriorated soil is called for, but I do not think that the credit of an Experimental Farm, whose object it is to introduce practices applicable to the *increase* of crop in cultivated and culturable soils, should hang upon the results obtained upon what is little better than a sand-hill

491 *Bengal Farms.*—Experimental Farms in Bengal are three in number, and they are all of recent creation, for, previous to 1884, there was no Director of the Agricultural Department of Bengal The three Farms are Dumraon and Burdwan, both established in 1885, and Seebpore, started in 1887. I visited Dumraon and Seebpore, but not Burdwan, indeed, the position of the latter is so unfavourable that it is contemplated to give it up Bengal Farms.

492 *Dumraon Farm* Dumraon Farm

covers 15 acres, and is intended to be an Experimental Station in the stricter sense

The Maharajah of Dumraon pays all the expenses which including the overseer's pay of Rs. 600 and rent amount to a net cost of Rs 1,200 annually An overseer was obtained from the Cawnpore Farm but he can only give partial attention to the Farm having the charge of other parts of the Dumraon Raj or Estate as well Occasionally one of the Assistants to the Director of the Agricultural Department visits the Farm, perhaps once

or twice a year, but it was evident to me, from the state of *crops*, that there was a lack of regular supervision

The first experiment I noticed was one on the growth of sugar-cane with different manures as well as by trying the Native against the Mauritius plan of sowing But the sugar cane crop was growing on land that was too wet and low, and the crop looked very inferior As an experiment this one was worthless Again the manures used had little relation one to the other, they were cow-dung, castor cake, saltpetre, and a mixed manure termed "normal manure In choosing manures, they ought to be arranged with *some regard to their constituent parts, so as to* enable an experimenter to gain some information as to whether it be the nitrogenous, phosphatic or potassic properties, or else the presence of vegetable matter, that proves most effectual, this point solved more special experiments can be tried with materials containing the particular ingredients But here the state of the crop rendered comparative results misleading Where the native and Mauritius system of planting were compared, the question was further complicated by manurial issues as well this seems to me very undesirable Single issues should be set out as far as possible and these only. There were no duplicate plots at all

The next series was on the manuring of winter rice sown broadcast, 15 plots (a far too large number) were taken up though in no case with duplication of experiment Shallow and deep ploughing for rice comprised two of the plots, a slight advantage being attributed to the latter The manures used were as before of a very varied kind, and allowed of no deductions being drawn except as concerned the actual material employed, but supplied no information as to the most desirable class of manure whether vegetable or phosphatic or saline Green manuring cow-dung lime, saltpetre, oil cake and sweepings were tried Saltpetre either alone or with lime, gave the best returns but on going into figures its use is found not to have been financially successful This I can well understand and it seems to me to need little practical demonstration to show that a very readily soluble salt like saltpetre is thrown away upon a crop that grows frequently with an inch or so of water standing on the ground

Another series on the same lines but with transplanted instead of broadcasted rice followed

The next was on wheat, with the same manures as were used for rice Here again, saltpetre gave the best returns, though the increase is stated to be year by year a declining one

I cannot say that I considered the Dumraon Farm a good Experimental Station The first mistake made with it was to take up the whole area, to divide it into squares and to cram in as many plots as would well go into the space The consequence is that there is no room for extension of experiment or for re testing what has been done Then, as all the experiments are manurial ones, the ground is practically done with, so far as future experiments are concerned unless with a considerable break of crop-growing without manure.

Next there is no duplication of plots and more especially of unmanured plots nothing seems to have been done to test the suitability or evenness of the land for experimental purposes and indeed the Report says ' the "surface of a large portion of the Farm is uneven and unless it is properly "levelled, it is idle to expect a uniform growth of crops As it is these "may thrive sufficiently well in the hollows and get stunted and burnt up "in the intervening patches of high ground The unevenness of the "ground also stands in the way of irrigation" This to my mind, surrenders the whole point as to the Farm being a good Experimental Station, let alone what I have said as to the absence of supervision and of design in the plan of experiment

Seebpore Farm 493 *The Seebpore Farm*

is only a little way out of Calcutta, and includes about 25 acres of which 15 acres are experimental The soil is rather heavy alluvial land with a good deal of clay It was formerly jungle land Its depth is about 2 feet, and

overseer College branch

when a modern bone mill is used

... Rs. 4½, introduced by ... It worked well when ... the soil, going 3' to 4 ... ng it would insist on ... he would do with a native plough

There was in a building on the Farm a good collection of implements of different kinds

Sorgho (*Sorghum saccharatum*) is largely grown as a fodder crop, and yields three cuttings in the year, a very good sale for it being obtainable in the town to people who keep cows

The use of bones as a manure is extensively tried, but, so far, I could not gather that the results were at all conclusive. Bones cost in Calcutta Rs. 2 to Rs 2½ per maund of 80 lbs.

... barley, oats, wheat, and ... riments, but one is upon ... Mauritius system of cane-

... has been taken up, ... on of experiments, ... little to cultivation, ... rial or unmanured ... d for experimental trials.

The cultivation is better than at Dumraon, and the fields seemed more ... ired ... nce ... to ... it ... to ... es ... arm (Madras), and these two cases afford a useful proof of what I set out earlier, (*see* paragraphs 446 and 490), *viz* that a soil may be either too rich or too poor for the land to serve as a suitable Experimental Farm One thing is very certain, that it would well repay the time lost at the beginning were more care given to ascertaining beforehand whether a field was a suitable one for experimental purposes

494 The Agricultural Department of Bengal has endeavoured to carry on experiments through a large number of *raiyats* and *zemindars* In the account of these it is stated that, from the nature of the circumstances, it was not found possible to give accurate quantitative results I have myself tried in vain to ... often contra- ... work on ... employed, Experiments through *raiyats* and *zemindars*.

Farms
Province

495 The foregoing account embraces the Farms which I actually visited when in India. The remaining ones that exist, but which I could not see, were those in Burma; these, I believe, are devoted mostly to the growing and curing of tobacco. The attempt has been made to grow wheat also, but the people do not take to it, as rice grows so much better. In Berar there used to be a small experimental field, but it is now given up, so also is one that formerly existed at Ajmere.

In the Punjab, in Assam, and in Coorg, there have not been any Experimental Farms.

CONCLUSIONS

CONCLUSIONS

496 Experimental enquiry, conducted by means of special Experimental Farms, is a necessity in India for the development of agricultural improvement It may be urged that the Farms which have already been in existence for some number of years have not been pronounced successes, and have fallen far short of what they were intended to accomplish, but, after visiting the Farms, and after reviewing the work done at them, I can only express my satisfaction at finding them so much better than I had been led to believe, and my surprise is great that so much has been accomplished with the imperfect and ever changing machinery employed The expense incurred for Experimental Farms, though perhaps rather large here and there, has, in my opinion, been by no means excessive, and the Farms compare very favourably in this respect with similar institutions in England and other countries

What is chiefly needed now is, that there should be a better system of guidance in laying out the plans of experimental work at Farms, better supervision, continuity of enquiry, critical examination of results, and publication and dissemination of useful conclusions in a clear and intelligible form

In accomplishing this, the association of a "scientific adviser" with the work of Experimental Farms will be invaluable

Farms, omitting those directly connected with educational institutions, should be of two distinct kinds, (1) Experimental Farms, and (2) Demonstration Farms.

The work of Experimental Farms should be, mainly —

(*a*) To institute comparisons between methods of cultivation practised locally, and those in use elsewhere, which it may be considered desirable to introduce

(*b*) To test upon different crops the effects of manures which are available, or which may probably be usefully applied in the future

(*c*) To introduce new crops and new varieties of crops

(*d*) To institute trials of new implements side by side with native or locally used ones

(*e*) To improve the breeding of farm stock

(*f*) To grow and distribute selected seed

(*g*) To be Depôts for the locating of stud bulls

Before any Experimental Farm is established there should be a definite reason for its existence, there must be efficient supervision, a suitable situation and soil A definite and well devised plan of experiment should be drawn up, the outcome of the experiment having a distinct bearing upon the practice of the cultivating *raiyat* There must be critical examination of the results, duplication and repetition of experiment, and, finally, publication and dissemination of the results, the issue of these in the vernacular not being omitted

The success of Experimental Farms must not be gauged by their financial result, and they must not be expected to pay their expenses, but a sum of money ought to be laid out annually for their efficient carrying on

Demonstration Farms should be established for the purpose of showing on a practical scale, and of bringing to the door of the cultivators, the results of what has been found on Experimental Farms to be an improved practice Such Farms should be expected to pay for their cultivation expenses

RECOMMENDATIONS

RECOMMENDATIONS

497 That agricultural enquiry be continued by means of Experimental Farms

That distribution of selected seed and location of stud bulls be undertaken by Experimental Farms as also the breeding of farm stock, where circumstances are favourable

That Demonstration Farms be instituted in connection with Experimental Farms, in order to set out the results of successful enquiry.

CHAPTER XIX.

CHAPTER XIX.

AGRICULTURAL EDUCATION.

AGRICULTURAL EDUCATION

498 It is not enough that improvements in agriculture should be effected by direct Government agency, and that measures, the result of enquiry and experiment, should be taken in the people's benefit, but it is necessary also that the people themselves should be brought to an intelligent understanding of what is being done, and that the endeavour be made to teach them how they may help themselves This is the work of education. In my second and third chapters I have shown how the spread of General Education will aid in removing many of those prejudices associated with "caste" and custom which render one class inferior to another in cultivating ability, and which frequently prevent the adoption of The influence of General Education.

spreads in his direction, he will become more intelligent, less afraid of authority and officials, less disposed to regard them as opposed to his interests, more able and willing to set forth the grievances under which he suffers, while in his practice he will become more ready to receive new ideas.

Departments will take up the subject of Agricultural Education or not, but it is a *positive duty* which they cannot evade unless released by the Secretary of State from the obligations put upon them. The importance of the subject was reflected in the prolonged and close attention which the Agricultural Conference at Simla gave to it, and in the several Resolutions which were passed upon that occasion.

My enquiry limited.

an opinion upon what I could see with my own eyes, such as the practice of agriculture or the conduct of experiments Agricultural Education, again, cannot be taken out of its connection with

General Education, and I had neither the time nor the power to acquaint myself with the systems of general education as carried out in different parts of India. My observations upon the various grades of schools where I think that agriculture might enter as

The tendency of education in the past

501 There is very [illegible] the past has been too m[illegible] it has been diverted from [illegible] staple industry of the country [illegible] Agriculture Agriculture is by far the most general pursuit, and it is that which contributes the bulk of the Revenue of the country According to the Census Re[illegible] of 1881, 72 per cent. of the whole male [illegible] specified occupation are directly a[illegible] estimate of the Famine Commissio[illegible] rural population live, more or less, [illegible] theless, it is found that the tend[illegible] cation at the present time is to draw the rising generation away from the land, and to give a purely literary training, which ends in a young man making his aim the obtaining of a post under Government, or the following of the profession, of a "pleader" in the Courts Agriculture is not regarded as a profession, but too often as a medium for deriving an income off the land; owners of land do not look after their property themselves, but leave it to the care of superintendents, and prefer to make money in the town by trading rather than by agriculture [illegible] (Rs 1,00,000) [illegible] no intelli- [illegible] dents, the [illegible] ck to the [illegible] education [illegible] nt at an [illegible] pointment [illegible] ement of [illegible] there is a [illegible] dignified [illegible] dura expressed it to me, "the cleverest son is sent to the Law, the next into "Government employ, the dullest one goes to Agriculture or else to Trade."

The following extracts may be given in support —

Sir E Buck's opinion.

"The fault of our educational system is, that nothing in the scheme of "instruction sufficiently connects the knowledge to be acquired by the son "with the cultivation of the paternal acres." (Sir Edward Buck's Minute on Technical Education, 1886)

Sir A. Mackenzie's opinion.

"There is need of something more th[illegible] "our graduates [illegible] have [illegible] Empire, "but no idea of exploiting its [illegible] A. Mackenzie's Minute on Technical Education [illegible]

Mr F A Nicholson's opinion.

"The education given has little or no connection with a lad's after life "There is nothing in it to teach him to farm it does not teach him to "observe, or think about, or think new thoughts about, his processes and "products." (Mr F A. Nicholson on the Condition of Anantapur, 1887)

502. The present system of education is not sufficient to create and maintain that interest in the cultivation of the land which ought to b [illegible] The remedy and its benefits.
the only way to [illegible]
for a part of the [illegible]
of such a course would soon be apparent, for, where so large a proportion of the [illegible]
surroundings, [illegible]
are familiar to [illegible]
in the literature and history of a foreign country totally different to their own. The benefit of a more technical course of education is, that it maintains the connection between the teaching which a lad receives and the calling which he is to follow in after-life, in no branch could this be more important in India than in agriculture. The teaching of the rudiments of science also is far more likely to lead to habits of observation, and of desire after enquiry than a purely literary training Even in the very simplest form of education the illustration of the lesson by means of the ordinary objects and operations of agriculture is the most ready help, and is more likely than anything else to awaken the interest of the scholar and to bring home the lesson to his comprehension. Object lessons can nowhere find more apt illustrations. Then as we go higher in the scale of education, the same subject is fertile in ideas familiar to the pupil, and then it is that an effort should be made to awaken his interest in the great industry, and to impart a knowledge of its principles which may be of use to him in his after-career. Nor need this interfere with the course of a lad's general [illegible]

the problem of agricultural improvement is so great a one it becomes all the more necessary that early in life a sound teaching should be imparted in the elements of agriculture, so as to enable those whose lives will be largely spent in its pursuit to enter it with a fair understanding of its aims and guiding principles.

503 The Agricultural Education of the masses though it is what must be aimed at, can at first have no immediate effect Progress must at first be slow.
There are not merely the scholars at the different grades of schools to educate but there are also the teachers who will require systematic instruction before they can properly direct the training of their pupils All this will require time to develop, but the sooner the work is begun the better In addition, there are landed proprietors who require education in agriculture, there are the future "agricultural experts" to whom the work of enquiry is to be entrusted and lastly, there is the large class of subordinate officials of the Land Revenue Department for whom an agricultural training is an undoubted *desideratum*

504. The existence of different classes for whom Agricultural Education is to be provided in the near future points to the necessity of beginning the work, not from the lowest level alone nor yet The direction in which Agricultural Education should proceed.

from the highest point alone, but from both simultaneously. Just as it would be unwise to neglect Agricultural Education of the higher type and to provide merely for instruction of an elementary nature without seeking to improve the standard in the future by the accession of men who have received a higher training, so would it be equally unwise to delay the commencement of the education of the masses until a fully competent teaching element had been provided which might cause the stream of agricultural instruction to filter down from the upper to the lower classes It seems to me that the best plan is, to make use of such resources as at present exist and to seek to improve them by securing a succession of teachers who have received a high class training and have in their turn become fitted to be the instructors of other more elementary teachers In short, I think that the work of high class and of elementary instruction in agriculture should go on simultaneously and *that no system will be satisfactory which does not provide for both.*

A University training such as can be provided at Colleges and special Institutions is requisite for the instruction of those who may be fitted to occupy the higher posts of the Revenue Service or to enter the Agricultural Department as "experts", so also for those who will become instructors at the High Schools and Agricultural Classes distributed throughout the country Again, for those who will occupy subordinate posts in the Revenue Department, or who may qualify as teachers of lower schools sound Agricultural Education of a *more elementary* nature will manifestly be called for also

It is not, therefore a question of whether education shall proceed from above downwards or from below upwards, but progress must be made in both directions simultaneously

Special Agricultural Colleges not required

505 Taking, for convenience' sake the highest instruction first, we have to deal with such agricultural education as would be imparted at Colleges or special Institutions where agriculture forms one of the subjects taught and where students prepare for a University degree or career The Poona College of Science and the *Saidapet College at Madras are instances of such Colleges*

The question arises at once, whether agriculture in its different branches should be taught at special Agricultural Colleges or whether it should merely form a part of the instruction at existing Colleges where a general training in science is provided In its origin Saidapet was *representative of the former* as Poona is of the latter. After careful consideration I express myself as not favourable to the establishment, at the present time of special Institutions for the teaching of purely agricultural subjects alone, but I advocate rather the utilisation of existing institutions where a training in science is given, and the tacking on of agriculture to the subjects taught. My reason for coming to this conclusion is that in the present state of agricultural knowledge in India I much doubt whether there is adequate teaching power to provide instruction in the various branches of a complete agricultural course, and also whether, in a purely Agricultural College, there would be sufficient employment

for teachers of ability in those departments of science alone which are connected with agriculture. The Madras Agricultural Committee (1890) reported that the results of agricultural education at the Saidapet College were disappointing, and that the sole object of most of the students joining the College was to obtain employment or promotion in Government service, very few indeed of them subsequently engaging in farming. The Poona College of Science, on the other hand, has only had agriculture as one of the many branches of science taught, and the results have, on the whole, been fairly successful. Within recent times the University of Bombay [illegible]

latter system, for [illegible] of special Agricul[illegible] sufficient call for [illegible] cannot as yet be [illegible] possible that in time, perhaps, there will be occasion for one or more Central Colleges of Agriculture, but there will always be a difficulty in finding a central place, more especially as the agriculture of different parts is so varied For the present I prefer, as I have said, the utilisation of existing Science Colleges and Institutions to the establishment of any fresh one specially for agricultural training.

[illegible] Teaching [illegible]

in great measure, consequent upon what has been noted at Saidapet and elsewhere *viz.*, that the aim of the students is not to study agriculture for its own sake, but for the sake of getting Government employ or preferment It is, of course, unfortunate that this is so, and especially that it is not merely a tendency, but an almost universal rule I do not think that there is much likelihood of a change, and therefore it is better to provide for things as we find [illegible] ll be long, I think, before we [illegible] orkers in pure science who [illegible] will it be with agriculture. [illegible] is nevertheless desirable to ensure, as far as possible, that the training shall be that which is most likely to be of benefit to the men in the spheres which they will subsequently occupy. It would unquestionably be well that the men who, later on, become Land Revenue officials, and who in their daily work are brought in contact with agricultural conditions and surroundings, should get some knowledge of the principles of agriculture during their earlier training Even if they do make the attainment of a University degree the main object, and study

Instanced in case of land Revenue officials.

from the highest point alone but from both simultaneously. Just as it would be unwise to neglect Agricultural Education of the higher type and to provide merely for instruction of an elementary nature without seeking to improve the standard in the future by the accession of men who have received a higher training, so would it be equally unwise to delay the commencement of the education of the masses until a fully competent teaching element had been provided which might cause the stream of agricultural instruction to filter down from the upper to the lower classes It seems to me that the best plan is to make use of such resources as at present exist and to seek to improve them by securing a succession of teachers who have received a high class training and have in their turn become fitted to be the instructors of other more elementary teachers In short, I think that the work of high class and of elementary instruction in agriculture should go on simultaneously, and that no system will be satisfactory which does not provide for both

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by having a *Demonstration Farm* attached to the College, where the students may see the actual operations of husbandry, and the cultivation of the different crops carried out They should also be taught to do the work on the farm themselves or have a piece of land which they can cultivate with their own hands This may be sufficient for a College career or for a University degree, but more is needed before a man can be turned out from a College, and be fitted to manage a farm of any size or to superintend an estate It i eeing practi-cal e Bhadgaon can a condition that passed students of Poona or similar Colleges should not be promoted to the management of a farm or estate until they have spent some time in practical work on a farm like that at Bhadgaon The complaints of landowners that they cannot get competent superintendents, would in great measure be remedied by a provision of this kind, and it would prevent men from leaving the different Colleges with nothing but a theoretical knowledge of agriculture

509 Passing from Colleges to High Schools, we have to consider the Agricultural Classes which, in the absence of any special College, have been established in several parts of India, and which are as a rule attached to the High Schools Those which I visited were at Nagpur Belgaum and Nadiad With the first named I was particularly pleased and I am confident that it is doing decided good It is quite true that here as elsewhere, the prominent idea among the students is to get into Government employ, but it must also be remembered that in the Central Provinces there is a steady demand for men who are to be employed in the Land far better have had , acquired followed to understand the condition of the people, their wants, and the ways in which agricultural improvement may be effected I was very much e obliged themselves t ricultural class and which he cultivated entirely himself, and the crops of which he was allowed to convert to his own use *A Demonstration Farm* is a natural and necessary adjunct of an Agricultural Class and on it there should be practical work carried out by the students If a certain area can also be devoted to experimental work it may be a further advantage but all depends upon the superintendence available Of 17 students in the Nagpur Class during 1889 90 14 passed well and obtained appointments as Revenue Inspectors

Agricultural Classes attached to High Schools.

Nagpur

It is worthy of note as showing the necessity of providing agricultural education of a high character, as well as that of an elementary nature that the Nagpur Agricultural Class is dependent for its teaching power upon the Poona College of Science, the

Principal and his two Assistants being passed students of that institution.

Nadiad

[illegible] High School [illegible] The [illegible] or the [illegible]

Belgaum

At Belgaum also, the Agricultural Class is attached to the High School, and a farm of seven acres is utilised for it The teachers must have passed at the Poona College of Science Agricultural Classes are likewise attached to nine of the principal High Schools in Bombay Each of these is under an instructor who has qualified either at Poona or at Saidapet, and who reports to the Poona College The examination papers are set from Poona College, and passed students are qualified to join the College

Value of Poona College for supplying teachers

The above instances show, if proof were needed, how necessary it is to maintain the agricultural teaching at the Poona College in a high state of efficiency.

High Schools

510 At High Schools more attention should be paid to the study of physical science, and the instruction should also be made more distinctly agricultural in its bearing than is the case at present Although there may not be the necessity which exists in the case of Agricultural Classses and Colleges, for having farms on which the scholars of High Schools may work, it is very desirable that there should be what I may best term *Illustration Farms*, on which the scholars may see the principal crops cultivated in the district, and have illustrated to them in this way the lessons which they are taught Illustration Farms of this kind will help to bring home the instruction given and to give point and interest to it

Illustration Farms

Middle Schools

511 In Middle Schools the elements of physical science should be taught, and it would be well, too were more attention given to drawing I noticed, when present at an examination at the Forest School, Dehra a great lack of power on the part of the students to represent by means of a figure any object about which [illegible] ere more extensively taught at [illegible] would be a considerable gain [illegible] roduced in Middle Schools by means of text book [illegible] mentary botany and physiol [illegible] nnection with these schools, [illegible] *Plots*, where some of the principal field crops could be grown on a small scale, just for the purpose of illustrating the lessons In the Central Provinces a scheme is on foot to establish School Gardens, on which the boys may work, and be allowed, as an encouragement, to keep the crop proceeds themselves

Drawing

Illustration Plots

School Gardens

Primary Schools

Agricultural "readers" and object lessons.

512 At Primary Schools the most that can well be done in [illegible] "readers" [illegible]

quickly comprehended by the youthful mind as the common every-

Calcutta, and that there was no show-case that attracted so much attention as those which contained clay models illustrating the simple agricultural operations in a village. It is the familiarity of the subject which attracts, and so it will be found in primary education, for no illustrations are so apt as those drawn from the every-day life of those who come to receive instruction.

513. There remains but one other class of schools of which I shall speak, the Normal Schools for teachers. The teachers cannot all go through a special training in agriculture, seeing that agriculture is but one of several subjects which they will have to teach, but it is very desirable, and, indeed, necessary, that they should receive sufficient instruction in it themselves to be able to understand and to intelligently teach out of an agricultural text-book. To merely teach agricultural principles as a lesson to be committed to memory, but not to comprehend what the words mean, is utterly useless Therefore, there should be some provis

whereby the

enable then

ments have

with the Agricultural Class held there, and probably similar arrangements could be made elsewhere for the instruction of the teachers of Primary Schools In some parts, the Central Provinces for example, peripatetic lecturers have been engaged to go from place to place, and to hold classes specially for this purpose, but the agency has, I believe, been found rather an expensive one. Whether this or some other plan, such as that adopted at Nagpur, of forming a special Class for teachers, be the better, depends much upon the

high class will be needed, there is not much to be expected so far as those now actually engaged in farming are concerned,

be specially given to the training in agriculture of those who are to instruct the future generation of cultivators, and the teachers in Primary Schools ought to show their capability for doing this.

Normal Schools for teachers

514. A manifest need is the issue of Agricultural Text-books and Agricultural Primers A few of these do already exist The best known is Mr J B. Fuller's "Agricultural Primer," originally written for the North-West Provinces, and subsequently

The need of Agricultural Text-books

re-written and adapted to the Central Provinces, upon Mr Fuller's transference to the latter. This little book is simply and admirably written, and in its 100 small pages it contains a mass of useful information set out in quite an elementary way. The Primer has been translated into Hindi, Mahratti, and Uriya.

More recently, an agricultural Text-book, suited specially to Southern India, has been prepared by Mr. C. Benson, Assistant Director of Land Records and Agriculture, Madras, and Mr. C. Subba Row, the Sub-Assistant Director. One or two other Text-books or Primers have also been issued by native agriculturists.

But very much more is needed than a text-book here and there. The conditions of agriculture are so diversified that any such book, if it is to keep its elementary nature, can be applicable only to quite a limited area. As Mr. Fuller says in his preface,—when he came to revise his North-West Primer and to adapt it to the Central Provinces, he had to re-write fully two-thirds of it, and he adds that not *one* book for the whole of the Central Provinces, but at least one for *each* of its *divisions*, is needed The same is true for any other Province of India and thus there is urgent call for simple but reliable and applicable text-books upon agriculture I look to the appointment of "agricultural experts" and the co-operation of a "scientific adviser" as likely to help greatly in this necessary and important work

Language is a difficulty in the spread of education

515 One of the difficulties [illegible] is, undoubtedly, *language*, or rat[illegible] I noticed this when I was at [illegible] the holding of an examination there In the higher Classes instruction is given in English, but the teaching is in the vernacular (Hindustani) for the lower Classes. The answers given by the pupils in the vernacular Classes were brought out with far more readiness than by the senior students, and it was often hard to make out whether the latter did not know the answers or whether they merely did not understand the questions.

It will be just the same with text-books A text-book in English will not be understood like one in the vernacular, and it is far more likely to be learnt off as a lesson and committed to memory. Even in one and the same Province several different languages and dialects will be spoken and the text-book will have to [illegible]

Vernacular text books

are so great, dependence ought not to be put on English text-books only, but India should supply its own. That this has been done to so small an extent in the past is a proof of the need of paying more attention to the furthering of agricultural education.

Teaching of agricultural chemistry

516. I have spoken in Chapter XVII, (paragraph 423) of the teaching of agricultural chemistry as a special subject, and have expressed my belief that, though useful as an adjunct, I do not anticipate any great results to follow immediately from it. Nevertheless, it is a subject which should quite rightly enter into a regular agricultural course, such as is given at Saidapet or at the Poona College, or into that of the Forest School at Dehra.

Relation of "scientific" adviser to agricultural education

517. The relation of the proposed "scientific" adviser to the c[illegible] b[illegible] u[illegible] I[illegible] t[illegible] nature. Certainly he can never exercise any *control* over education, or prescribe on what lines it is to run. The most he can do, it seems to me, is to generally watch its progress, and, possibly to throw out suggestions for its improvement, but more he can hardly do, even had he time for it, which he most certainly would not have. Again, it would be inadvisable to have any conflict of authority between the Agricultural and the Educational Departments, and on this account, too, I think that the "scientific adviser" could do little more than express his opinion when asked, or make, as occasion permitted, some suggestion as to the line which agricultural education should take.

518. The question next arises: granted that there is a need of men more agriculturally trained, what inducements are to be given to them to pursue the study of agriculture? If young men go to other [illegible] agriculture, [illegible] as good "pr[illegible] employ. T[illegible] ply of men to fill posts in it; Land Revenue Inspectors are required whose business is with the people in their agricultural relations, and who have to do with the soil and the crops. Surely those best fitted are the ones who have had an agricultural training, and the administration of matters concerned with the land will be best carried out by the men who understand agriculture best. In England a land steward is not a man who is taken out of a bank, or who has done no more than take a high University degree in classics or mathematics. So should it be with Land Revenue Inspectors, they should be men who have passed through the Agricultural Classes, or through Institutions that give a training in agriculture. In the course of my tour I met many Inspectors whose mind seemed to be quite a blank on the subject of agriculture, in other parts, as in some districts of the Central Provinces, I found them to take a decided interest in agriculture. These latter were men who had passed through Mr. Fuller's Agricultural Class. In Bombay it is now provided that all candidates for the staff of Inspectors of Village Records must qualify by passing a course in agriculture,

I cannot put these views into better general terms than those adopted in the following two Resolutions adopted at the Simla Agricultural Conference, in October 1890:—

RESOLUTION VI.—It is highly desirable that the claims of men trained in Scientific Agriculture to appointments in the Revenue and cognate Departments should be as freely recognised as those of men trained in Law, Arts, and Engineering.

RESOLUTION VII.—That where appointments in the Revenue or cognate Departments are made on the result of competitive examinations, Scientific Agriculture should be included as an optional or necessary subject in the examination course.

Forest students

The Forest Department has for some time past felt the necessity of having better-educated men to occupy the post of Sub-Assistant Conservator. Efforts are now being made to effect an improvement in this direction, and the introduction of a more agricultural education among these men would qualify them better for their work.

Patwaris

Lastly, as regards the hereditary class of keepers of Village Records (*patwaris*), it would be a clear advantage if these men, whose office passes on, as a rule, from father to son, were in their early life to receive a training in the principles of agriculture, and also in drawing, instead of having, as is now the case, to be formed into special Classes later on in order to learn their particular work.

Classes of Natives for whom agricultural education is needed

519. It may be desirable here to summarise the different classes of Natives for whom agricultural education should be specially provided:

(1) "Experts" of the Agricultural Department.

(2) Subordinate officials of the Land Revenue, Settlement, Forest, or cognate Departments.

(3) Teachers of agriculture at High Schools.

(4) Teachers of Middle and Primary Schools where the elements of agriculture are taught.

(5) The youth of the cultivating classes.

(6) Non-official landed proprietors (*zemindars*, etc.).

Agricultural Colleges and Classes

520. It now remains for me to note briefly upon the Agricultural College, Classes, and other Institutions which I visited.

Poona College of Science

To take, first, the Poona College of Science, so far as its agricultural course is concerned.

This college in its agricultural branch is virtually the Agricultural College of the Presidency, and those who have had anything to do with it know how greatly its success has been the outcome of the devotion of its energetic Principal, Dr. Theodore Cooke. Successive Governors of Bombay, and more

teaches agriculture for two months in the year here. In the first year mathematics and natural science (heat, botany, and agriculture) are taken up, in the second year, higher mathematics natural science (chemistry and systematic botany), veterinary science, and agriculture, in the third year, natural science (agricultural botany, geology, and chemistry with analysis), surveying, veterinary science, and agriculture

[illegible]

year, and be made the principal subject during the third year, when, too, it would be quite early enough to take up veterinary work

What I should suggest would be :—

First Year's Course

Mathematics	Elementary Botany
Physics	Elementary Geology.
Elementary Chemistry	

Second Year's Course

Chemistry (Theoretical and Practical)	Drawing
Biology	Agriculture

Third Year's Course

Agricultural Chemistry	Surveying
Agriculture	Veterinary Science

[illegible]

The principal requisite for the Poona course is, to my mind, to make provision that the students have more acquaintance with the practical side of agriculture, either by themselves working upon the farm or by having a portion of land which they may cultivate themselves, or else by spending a certain time upon the large farm at Bhadgaon Certainly, too, before men pass out from Poona to take charge of estates, they ought to have previously qualified by a residence at the Bhadgaon or similar farm

[illegible]

[illegible] made lately in the [illegible] the Gaekwar has Baroda College.

An agricultural branch of the Baroda College has been formed, and is affiliated to the University of Bombay for the diploma in agriculture,

522 The other *Bombay Agricultural Institutions* which I visited were the farms, or rather fields, in connection with the Agricultural Classes attached to the High Schools at Belgaum and Nadiad. As mentioned a little before, there are Agricultural *Classes attached to nine of the High Schools in Bombay.*

Belgaum

... of the local funds, ... s in extent, and the ... gives as a grant ... better and Engli ... atti are provid ... rs must have pas ... at the Poona College

Nadiad

At Nadiad the farm of the Agricultural Association is thrown open to ... students attending the Agricultural Class of the High School A muse... with specimens of crop products, implements, etc, is attached

523. Passing next to Madras, the *Saidapet College* calls ... special attention. Its history has been dealt with in the Ir... chapter (*see* paragraph 488), and now I have only to remaure, ... what I noticed when I visited the College and Farm. ... be

Saidapet College

Of the unsuitableness of the Saidapet Farm, either as an experime... par- even as an educational farm, I have already spoken, and, after having ... I am not inclined to regard at all favourably its proposed extension, eve... sses farm for teaching purposes ... ally

... the

... a master of the ... istance, ought to ... a ... icul- tions demanded in ... only be attainable by a very few, and it would be far better ...

the teaching had to be *worked up to* it, instead of the syllabus being ...

the College.

A syllabus should not be framed so as to be far above the heads of the pupils, and appal them with the array of all that they have to get up for it, but it should be set so as to be an index of the requirements which the education given could fairly supply

The main point to determine with regard to the Saidapet College is, I think, what its future is to be Is it to be an Agricultural College? If so, the course ought to be a more purely agricultural one, with superfluous subjects struck out, and practical work substituted for them If, however, it is to be a general Science College, then let this be clearly understood, and let agriculture merely take its place as one of the subjects taught

524 The Central Provinces do not possess any Agricultural College, or even Science College where agriculture is made a special part of the instruction The nearest approach to this is the Agricultural Class at Nagpur, of which I have already spoken favourably

At the time of my visit there were 39 students, 10 of whom were boarders, and most of them Brahmans The principal object of the students is here, as [illegible] *Nagpur Agricultural Class*

[illegible] that the students are obliged them-sel[illegible]

[illegible]

it

A certain number of the scholarships of the Educational Department are [illegible]able at the Agricultural Class the course extending over two years The [illegible]ching agency is entirely supplied from the Poona College of Science

I thought the arrangement of subjects taught, and also the syllabus, very [illegible] satisfactory indeed, there were no superfluous subjects, and all of them had a direct bearing upon the principal subject, agriculture They comprised agriculture, elementary chemistry, botany, geology, elementary veterinary [illegible]

Class also

[illegible] s, or educational [illegible] Instead of this, [illegible] lected Natives to England to study agriculture at the Cirencester College. This has, however, now been abandoned. In place of it, it is proposed to have an agricultural branch at the Seebpore College of Engineering, near Calcutta, and to utilise the Seebpore Experimental Farm which adjoins the College. *Bengal*

In the North-West Provinces there is no Agricultural College, nor special provision for the teaching of agriculture. *North-West Provinces.*

Punjab Veterinary College, Lahore

In the Punjab the only step in an agricultural direction has been the establishment of a Veterinary School at Lahore. This was started in 1882, and has been decidedly successful.

Forest School, Dehra

526. The last institution that I need mention is the Forest School at Dehra

This, though not a College for imparting instruction in agriculture, has in some ways, nevertheless, an agricultural bearing.

There are courses for Foresters (conducted in Hindi), for Rangers (in ... Conservators The ... bout ... nts ... fter ... as vacancies occur It is almost unnecessary to say that out door instruction ... scheme of instruction drawn up ... teaching, in the main, to be ... botany, and entomology, the ... during a few weeks by non- ... suitable chemical laboratory at ... apter, it is hoped to provide shortly for regular instruction in agricultural chemistry

vegetation

In listening to the examinations in other subjects I was struck by the ... t illustrate ... amination, ... s that of ... g a rock, ... emselves in ... out of a text-book

... itself, ... Thus, ... by the ... not be ... nd try ... xamin- ... March ... its pro ... except ... gineer- ... or any ... *â voce* examination is more than enough to ascertain a man's real knowledge of a subject, and I should like to see this supplemented by written periodical examinations These are points which can readily be remedied, and it is but right that I should say I thought very well of the teaching as a whole There

is a demand for a better class of men to fill the post of Sub-Assistant Conservator, and it is very desirable to maintain the instruction at the Forest School in a high state of excellence, so that the men sent out may have a [illegible]

CONCLUSIONS

CONCLUSIONS.

527 The spread of education will be an important element in the improvement of agriculture It will do much to remove the prejudices attaching to "caste" and custom, which prevent progress in agricultural methods, and it will give rise to a more intelligent farming class

In a country where, as in India, agriculture is the chief employment, Agricultural Education especially should be encouraged Until lately the tendency of education has been in a purely literary direction, and has turned attention away from the land rather than towards it, the fault can now be best remedied by substituting Agricultural Education for a part of the present educational programme. The work must proceed simultaneously from above downwards and from below upwards Elementary instruction should be given in Primary Schools by means of "readers" and "object lessons," which introduce familiar agricultural subjects In Middle Schools the elements of physical science, the use of Agricultural Primers, accompanied by *Illustration Plots* on which the ordinary farm crops are grown, should form part of the instruction In High Schools more attention should be given to physical science and to agriculture, and *Illustration Farms* or fields should be attached to the Schools Agricultural Classes should be established where Colleges or Institutions that specially teach agriculture do not exist, and these should have *Demonstration Farms* attached, and land on which the pupils can themselves work

Special attention should be directed to the agricultural education given in Colleges, in order that the teachers supplied to High Schools and to Agricultural Classes may be well trained men, and that the Land Revenue, Agricultural and cognate Departments may be supplied with subordinate officials who have studied agriculture, both theoretically and practically

I do not consider it advisable to establish special Agricultural Colleges, but I think that it would be better to utilise existing Colleges of Science and to form agricultural branches at them Universities should encourage the study of agriculture by making agriculture an optional subject in the course for a degree, and the

claims of men who have passed in agriculture should be fully recognised for appointments in the Revenue and cognate Departments. There is great need of Agricultural Text-books suited to the circumstances of the different parts of India, and these should be in the vernacular as well as in English.

RECOMMENDATIONS.

RECOMMENDATIONS

528. That General Education be extended among the agricultural classes.

That Agricultural Education form a part of the general educational system, and be introduced as a prominent subject in the Schools of the country

That Text-books on Agriculture, adapted to the different parts of the country, be prepared as early as possible.

That encouragement be given to the higher study of Agriculture by recognising more fully the claims of men who have passed in scientific agriculture, for appointments in the Land Revenue and cognate Departments.

CHAPTER XX

CHAPTER XX.

AGRICULTURAL DEPARTMENTS

AGRICULTURAL DEPARTMENTS

Scope of this chapter

529 The previous chapters have of necessity been concerned largely with the work of Agricultural Departments, considered under the different heads selected for those chapters. There remain, however, some few matters which may be usefully discussed, but which do not come specifically under any of the foregoing heads These I shall treat of in this concluding chapter

The training of junior civilians in agriculture

530 The origin, development, and general history of Agricultural Departments in India have been narrated in Chapter I, as well as their scope and aims But their constitution has not been fully dealt with

One of the most important matters, to my mind, and one to which, it seems to me, far too little attention has been given in the past, is the early training of the men who are to form the *personnel* of Agricultural Departments, and more especially of those who may in future be appointed Directors of Agricultural Departments

The necessity of guiding in a more scientific and more agricultural direction the training of Indian Civil Servants who may, later on, occupy posts in Agricultural Departments, impressed itself strongly upon the Famine Commissioners in 1880 and has also been made the subject of representations by successive Secretaries of State The Famine Commissioners laid considerable stress upon the training of junior Civilians in agriculture, and they recommended—

Recommendations of Famine Commissioners 1880

(1) That more weight should be given to natural and physical sciences in the open competitive examination.

(2) That agricultural and organic chemistry should replace some of the compulsory subjects in the intermediate and final examinations of probationers for the Civil Service

(3) That candidates who distinguish themselves in these subjects should, further, be allowed to spend an additional year in England for the purpose of studying agriculture, the time to count as service on two-thirds pay

(4) That these selected officers, after a period of service in the ordinary line in India, should be enlisted in the Agricultural Departments

(5) That, in the meantime, a few selected junior Civilians should be sent to England after five years' service to study for a year or more at some School of Agriculture

Although these proposals had a great deal to recommend them, there were obvious defects which the Government of India, with, I think, much justice, pointed out in their reply. It was urged that a knowledge of agriculture could only be of special value to a few in the Civil Service; that a Civilian must first be fitted for ordinary executive and administrative functions, and that his probationary training in England should be framed with this view. *The Government of India's views*

with botany, geology, and zoology. The Government of India further proposed to give definite privileges to officers selected in India, to induce them to undergo an agricultural training in India, *viz.*, by allowing men selected by Local Governments to take furlough after five years' active service (instead of the usual eight years), and by authorising Local Governments to select one officer every two years to go on furlough to England to study agriculture. Lastly, they considered that every Revenue officer should have a rudimentary knowledge of Surveying, as practised in India for the purposes of Land Settlements.

To these proposals the Secretary of State gave, in December 1883, a general approval. He allowed agricultural chemistry to be an optional subject in the final examination. But he objected to the withdrawal of officers from their duties in India, and declined to lay down any general rule, though consenting to act, in special cases, in the spirit of the above proposals when Local Governments submitted special recommendations. *Secretary of State's decision December 1883*

v forms, number at the provide *Agricultural chemistry a subject of the final examination*

531. With what has been done I can, in the main, agree. I do not think it is possible to send out Civil Servants who shall be *My conclusions*

tive officer. I do not think, therefore, that practical agriculture can usefully be included in a probationer's examination. I can,

in England

and, besides

agriculture is

ation that a

man would by so doing get out of the regular line and thus raise

difficulties as to promotion, time of service, pay, etc. But I do endorse most thoroughly those recommendations of the Famine Commissioners, and of the Government of India, which have for their object the giving of more weight to the study of Natural Science I maintain that what is needed is not so much to have men or I will say Agricultural Directors especially, who shall be practical agriculturists, but to have men of a scientific turn of mind who have some knowledge of what science has accomplished in the past, and of what it is likely to effect in the future, men who will have some appreciation of scientific work and of workers in science Now, this can only be gained by an early training in scientific subjects, and, although the details of agricultural practice can be acquired at a later date, the pursuit of scientific methods and their application to practice cannot I have been much struck in India by the almost complete isolation in ideas of the few men who have gone out to the country possessed of some knowledge and appreciation of natural science They have, as it were, stood almost alone unappreciated, or rather, not understood by their more classical or mathematical brethren Yet I can see quite well that, among the men who have done most to help on agriculture, in many cases the impulse has been given by their love and appreciation of natural science I think that the tendency of modern education to proceed in the direction of a more liberal and scientific training will carry with it important results which will indirectly influence even Indian agriculture, and that, with the coming of more Civilians to India who have had a certain amount of training in natural science, a class of men will be obtained whose presence will aid the improvement of agriculture by making the application of scientific methods more easy, and better appreciated.

Necessity of giving more weight to the study of Natural Science

I think, accordingly, that the giving of more prominence to scientific subjects, both at the open competition and at the later examinations for the Civil Service, would be attended with decided benefit, and that from the men who have distinguished themselves in this branch some might be selected who would subsequently prove useful officers in the Agricultural Department

Agricultural chemistry at the final examination

532 As to agricultural chemistry, now an optional subject at the final examination, although I am, as an examiner myself, obliged to allow that many candidates take up the subject purely with the view of swelling the total of the marks that may stand opposite their names, I have every year, so far, found some few men who have shown more than a passing interest in it, and who, if opportunity were given them of subsequently turning their attention in an agricultural direction, would, undoubtedly, be able to derive and to impart benefit from their study of agricultural chemical principles It is men such as these who should be noted when they have done well and it is from them that the future Agricultural Directors might advantageously be selected

Employment of junior Civilians in Department of Land Records and Agriculture

533 But it is not enough to merely note such men, it is necessary, too, that they should, on arrival in India, be brought into contact with agriculture and its conditions, and be encouraged to study it in its varied relations

It is universally acknowledged that a young man on his first coming out to India is, to put it broadly, of very little use. He cannot be entrusted with any post until he has got to know something of the language, the people, and the district where he is. As a Collector of experience told me, "the best thing is to send the new "comers out into the fields for four months or so and then they may "begin to pick up something." If, on the other hand, they are left to gather their experience in the court-house (*cutcherry*) they soon lose the little agricultural knowledge they had, and never get to understand thoroughly the conditions of the people and of their agriculture

It would be well, therefore, that when men come fresh to the country, a certain proportion should be drafted into the Depart- [illegible]

in the establishment of "Fuel and Fodder Reserves" if he has not had some insight into the circumstances which call for their creation? At the same time, these junior Civilians might be instructed in the principles of Land Surveying At the departmental examinations, after arriving in India, men are examined upon the local tenure system, and upon the law of the district where they [illegible] Departmental examinations in agriculture.

cultural Directors were selected from men who had undergone some training of this kind, instead of being chosen (as at present) without any or with very little regard to their agricultural knowledge or powers, it would be very much better for agriculture.

It would also be a useful stimulus to these men if encouragement were given them to study agriculture in other countries when absent upon furlough. Encouragement to study agriculture when upon furlough

534 It is not only in the method of selecting Directors of Agricultural Departments that a better system should prevail, but it appears to me that there should be some alteration as regards the position which a Director occupies, and chiefly in his relation to the existing Revenue Administration At present the description I have heard applied to the Director that of being a "fifth wheel of the coach" is very near the truth He has no administrative powers, and can only act as an adviser, he has not even the power of fining or of dismissing an Inspector who does not see properly to the keeping up of the Land Records in his district, but he must refer the matter to the Revenue authority His title "Director of the Department of Land Records and Agriculture," as I have [illegible] The position of Directors of Agricultural Departments

Administration, and not have his duties confined merely to the giving of advice. As I pointed out earlier (Chapter VI, paragraph 113), he should have a large share in the management of *taccavi* advances for the purpose of digging wells, etc., even if the actual control and disbursement cannot be left in his hands. Again, he should have the power of making representations, as to the giving, in special cases, of exemption from assessment, and of reporting upon instanc [illegible] Revenue officials, a Direct [illegible] present. The post is one [illegible] senior man ranking with the highest grade of Collector, but a little below a Commissioner. I would much prefer to see the title "Commissioner of Agriculture" given to him instead of the present one, as the title would more adequately describe his duties and define his position.

Commissioner of Agriculture

The need of touring

535 The desirability of an Agricultural Director's spending a *considerable time each year in touring should be self-evident,* and yet there are Provinces in India where the Director does not go on tour at all, or where very little touring is done To get by personal enquiry and observation a knowledge of the agricultural requirements of a district, whether as regards water supply, wood supply, [illegible] nature of [illegible] with- [illegible] e. If this part of the work be given up, it is little to be wondered at that the Director will leave out agriculture from his title and confine himself to Land Records.

The Secretary of the Imperial Agricultural Department

536 The above remark applies in a special manner to the Secretary [illegible] ous duties [illegible] he cannot [illegible]

[illegible] guiding the [illegible] orcing upon [illegible] individual [illegible] ose, and the [illegible] perial Agri- [illegible]

with the office of Secretary, duties which are more akin to those which would fall to the lot of an Inspector General.

While on this subject, I might add a word expressive of my belief in the usefulness of occasional Conferences, for the purpose of exchanging views on agricultural questions, and of bringing into closer harmony the work of Imperial and of Provincial Agricultural Departments. My own experience of the Conference held at Simla, in October 1890, impressed this very clearly upon me, [illegible] ion which [illegible] ives com- [illegible] y brought [illegible] consider- ation.

The value of Conferences.

[illegible] partments may be [illegible] which the Govern- [illegible] the Operations of the Departments should be made.

Classification of the work of Agricultural Departments.

These are as follows :—

I. Organisation and Maintenance of Village Records.
II. Analysis of Districts with reference to security from Famine.
III. System of Collection of Revenue and Rental in precarious Tracts.
IV. Measures of Protection against Famine.
V. Agricultural Experiments, including Farms.
VI. Cattle-breeding and Veterinary Establishments.
VII. Agricultural and Fiscal Statistics.
VIII. Trade and Trade Statistics.
IX. Museums, etc.
X. General.

Most of these subjects have already been dealt with in this Report, while others, such as Statistical Records, are not connected with my special work. It will but be necessary to touch upon a few general points not already noticed, and to mention special features of the work of individual Provincial Departments.

538. I frequently had the opportunity of inspecting Village Records, and of watching the work of the Village Accountants (*patwaris*), District Inspectors, etc., as also the maps relating to Set- [illegible] entrusted.

Village Records.

The one matter in which there seemed to me to be a lack was, that the statistics obtained, say, for individual fields or holdings, need to be collected together and to be then digested. The main points brought out by the *figures* require translation into *words*, so that useful general conclusions may be drawn from them.

They need to be collected and digested.

Then, there are apparent disc
and general results ought to be collected for each district. The real requisite is, it seems to me, a central Bureau of Agriculture, where the returns would be gathered together, examined, ... use Something ... O'Conor for the ... with its Agriculture.

In Bengal, in consequence of the existence of a permanent settlement, there are no Village Records, except those relating to Government and private Estates. These Estates cover altogether about 20,000 square miles There is, consequently, no regular *patwari* staff. When speaking of indigo cultivation in Behar I mentioned the difficulties which arise in consequence of there being no Record of Rights, from what I could see I should be strongly of opinion that the Cadastral Survey of Behar, which it is intended to set on foot shortly, will be productive of immense benefit, in that it will put an end to the troubles that have arisen from the absence of any Records defining and demarcating the different holdings and occupation rights

Analysis of districts

539 The Analysis of districts is a most important work, and one which in many cases has been well done. But it has, so far, had reference mainly to the question of security against famine; what is now needed is, that there should be an analysis of districts with regard to their general agricultural capacity and condition. In such work the employment of trained "experts" will be very necessary.

Bombay

The most elaborate work as yet done in the analysis of districts has been the compilation of the "Statistical Atlas of Bombay" This atlas comprises an immense amount of information and statistics respecting the agriculture of the different districts of the Bombay Presidency.

North West Provinces and Oudh

In the North-West Provinces and Oudh the Annual Reports of the Department give, from time to time, statistical maps showing the distribution of different crops throughout these Provinces

Madras

which I have made copious use in this Report.

Central Provinces

Punjab.

Nothing has yet been done in this direction in the Central Provinces or in the Punjab, beyond what is contained in different Settlement Reports

Bengal

In Bengal, however, a few districts have been specially reported upon, notably the Dacca District by Mr. Sen, and the Lohardaga District by Mr Basu. I have read both of these Reports

with considerable interest, and I think it would be a great advantage if the work were continued successively for the different districts throughout the Presidency.

540. Under "Measures of Protection" are included the establishment of "Fuel and Fodder Reserves," the formation of plantations along canal banks and railway lines, arboriculture, irrigation; *taccavi* advances for digging wells, and for other purposes, reclamation of ravine and salty land (*usar*), embanking of land, emigration, etc. Sufficient has already been said under each of these headings. Measures of Protection

541. [illegible] Farms," it [illegible] ese call for [illegible] ultural Ex- [illegible] North-West [illegible] universally successful, and in several instances it has been decided to give up Shows which were formerly held regularly. The non-success has been, perhaps, most marked in Madras, and what appears to me the chief reason of failure is, that the Shows have merely been held because the Provincial Agricultural Departments ordered that they should be held, and not as the outcome of any general interest on the part of the people or of would-be exhibitors. During my tours I had the opportunity of visiting two or three Agricultural Shows, and I was much struck by the differences between them, even in the case of districts not very far apart. Thus, the first one I went to, *viz.*, that at Saharanpur, though it was interesting in some respects, compared very badly, alike in the exhibits and in the interest taken, with the Show held a little later on at Meerut (Nauchandi Fair). I put this down mainly to the lack of local interest taken in the former, and to the little [illegible] Agricultural Shows

[illegible] ...ss depends ...vidual

he has it largely in his power to make the Show a success or the reverse. Where, as I found to be the case in Madras, a Show was held mainly because the Government had decided that there should be one, it is not to be wondered at that the interest aroused was small. At Saharanpur no effort appeared to have been made to foster local industries, and the exhibition of local work was very inferior, at Meerut, on the contrary, the exact reverse was the case, and an admirable collection of the results of native and local talent was to be seen. Turning to the more agricultural side, I must say that I was quite surprised to see at Meerut a Show which would by no means have compared unfavourably with the Shows of some of our local Agricultural Societies in England. Horses and cattle especially made an excellent exhibition, whilst ploughing [illegible] Exhibition of local industries

At the Meerut Show I noticed particularly the horse ring. It Horse ring good.

was admirably constructed, and quite picturesque with its enclosure of bamboo fencing topped with straw The arrangements for the entry and exit of the horses, and for sending them round the ring, as also for the judging, were capital

In some matters I would venture to suggest possible improvements.

Definite fixtures

I have seen it mentioned that in some cases the dates on which Shows are to be held are not fixed long enough ahead, and are altered after they have been once fixed, also that they are not sufficiently advertised Both of these points must militate against the success of a Show. The fixtures ought to be made well ahead, and the dates be rigorously kept to, so that the Provincial Agricultural Department can issue, in advance, a list of the Show fixtures for the whole year. If dates are changed or if fixtures are left uncertain, people are sure to lose interest, and it also prevents proper advertisement being given to a meeting The notices of the Show should be in the vernacular, and the more widely distributed they are the better.

Good advertisement

Annual Provincial Show

It is well worth considering whether it would not be a good plan to follow the plan adopted by the Royal Agricultural Society of England, and to have one Great Show annually in a Province (the *locale* being changed from year to year), thus taking in turn the place of the ordinary local Show held in any particular district To this Show the Government subsidy might be confined, and a regular *rota* being determined upon, each district would be visited in turn and more outside interest be aroused

Practical judges.

Next, every effort should be made to get good practical judges.

It is, I know, the practice always to turn to the Collector, or to the Director of the Agricultural Department but it does not at all follow that they are the best agricultural judges

System of judging at Horse Shows

In the awarding of prizes for horses, I noticed that as many as five judges are frequently appointed, one judge taking into account, strength, another judge, quality, a third, soundness, and so on, 20 points may be awarded for each item, and the decision is given according to the highest total found on adding up the marks which each judge awards in his particular section. There is, however, *no separate veterinary examination I very much doubt* whether it is in the power of any judge to examine and to allot exact marks for one individual quality possessed by a horse, apart from the others which it has, it is rather by a setting-off of one against the other that a judge should base his award. Besides, the difference of standard necessarily adopted when as many as five judges officiate at once, introduces errors which, I believe, are greater than the advantages gained by collecting the opinions of several different judges As a consequence, on looking into the figures when made up to a maximum of 100, I found that the differences even with this large number of marks, were generally very small *and it was seldom that as much as 20 marks separated* the best from the worst horse in a class, although the judges allowed to me that the real differences amounted to very much

more; and so, too, it proved, for, in the not infrequent case of a "tie" occurring, the judges, without hesitation, expressed their decided preference for one animal over another, although the totals of the marks obtained on the individual system of judging were equal. There should, I think, be a veterinary examination of the horses, and unsoundness ought to *disqualify* and not merely to *reduce* the marks awarded.

A Horse Show lose- ... Horse fair.
plan generally adopted ...
forming practically a I ...
arranged in classes, and being put side by side so that they can be compared. I was told that this arises from the fact of one man being in charge, possibly, of a number of different horses, and not being able to attend entirely to one, still it is a defect.

... Shows is that of Catalogue
rresponding num-
est taken

From what I saw of poultry exhibited at Shows, I thought that very considerable improvement might be effected if more attention ... Poultry at Shows.

The ...
open to g ... Prizes for grain samples

...

off the field of the particular exhibitor. If prizes are awarded for ...

...

the best crop grown on a farm or field,—in fact, farm prizes. This would do a great deal more than grain prizes in stimulating improvement, and would be free from the objections to the latter. Farm prizes preferable

In regard to the exhibitors themselves, more care should be exercised in order to ascertain that they are *bona fide* exhibitors and cultivators. There is little doubt that in many cases men have made it a regular business to "farm" the prizes offered, by the aid of some particular exhibit of which they have obtained the use, though they may not be the genuine owners or exhibitors. Such abuse must have the effect of keeping the genuine cultivators from exhibiting at Shows. *Bona fides of exhibitors.*

The last point to which I shall refer in this connection is the trial of implements Trials of implements

Without doubt, a considerable amount of interest is aroused by competitions of this kind on Show grounds, but I am afraid that they are not always carried out with sufficient care, and it would be much more satisfactory if more exhaustive trials were conducted at Experimental Farms. The latter are the places where such trials can best be made, and in the case of new implements, they should be submitted to rigorous tests before the *imprimatur*

Agricultural Departments should not compete with purchased implements

[illegible] em. Again, it is [illegible] Departments to [illegible] competitive trial a number of implements of different makes which have been purchased by the Department. This appears to me hardly fair upon the makers or inventors of the implements, for the success or non-success depends very much upon the particular implement which the Department happens to have, the time at which it was purchased, and the way in which it has been kept and used Thus, a sugar-mill of a particular make, which the Department has bought some years previously, and has probably used also in the meantime, may be brought into competition with a brand-new machine exhibited by some rival maker If there are to be these competitions, the credit of the makers should not be dependent upon a machine exhibited by someone other than themselves, but they should have the opportunity of being represented by the latest and very best machine which they can turn out at the time, after that, in the event of failure, they would not have any reason to complain that they have not been fairly represented.

I notice that one year, in a competitive trial of sugar-mills at Saharanpur, the number of points awarded to a mill exhibited by the makers themselves was 88, while one of a different make and exhibited by the Agricultural Department had 87 points given to it Such minute distinctions as these, under the conditions of a rough trial, ought not to be drawn, and the fame of one firm should not be made at the expense of another, when there is no practical difference between rival exhibits, and more especially when one firm is represented by a new machine, and the other by one probably [illegible]

Shows in Bombay

In the Bombay Presidency some six different Shows are held annually, the annual [illegible] Rs. 8,000. The Ho[illegible] are the best-known [illegible] successful.

North West Provinces and Oudh

In the North-West Provinces and Oudh the chief Shows are those at Aligarh, Meerut, Saharanpur, Etawah, and Muttra Government awards over Rs. 1,000 annually for cattle prizes In connection with these Shows the services of Mir Muhammad Husain, the Assistant Director of Agriculture, are invaluable, and to his energy their success is in large measure due.

Madras

In Madras the chief Shows are those at Bellary and at Salem.

Bengal

In Bengal occasional Shows are held at about five different towns.

Purchase of horses by Army Remount Department.

At the different Shows held throughout the country a stimulus is given to Horse-breeding by the purchase of young stock for the Army Remount Department, some of the officers of which attend the Shows and buy animals which they think likely to meet

army requirements in the future Mares are also selected to be "branded" mares, and thus become eligible to be served by Government stallions.

542 Under the head "Experimental Farms" are also classed seed distribution and sale of implements Cattle breeding, veterinary establishments, etc, which come under the next head, have also been fully referred to before *Other branches of the work of Agricultural Departments*

The other heads under which the work of Agricultural Departments falls do not call for special mention by me

543. The Organisation of Provincial Departments of Agriculture is not alike throughout India In the Punjab, for instance, there is no separate Department, but it merely forms a part of the Land Revenue Administration, its Report being included in the general one of the Administration and not being given under the different heads prescribed by the Government of India *Organisation of Departments in different Provinces* *Punjab*

In the Central Provinces there is a Commissioner of Agriculture, who combines with his duties those of Commissioner of Settlements *Central Provinces*

In Madras there was no separate Department until 1882, and the Director is not a travelling one, but always remains at head quarters *Madras*

In Bengal there was no separate Department until 1885, and the one then started was established only as a temporary or tentative measure *Bengal*

In the North-West Provinces, and in Bombay, there are separate and complete organisations *North West Provinces* *Bombay*

544 The Agricultural Department has frequently been found fault with on account of the mistakes which it has made, and of the number of minor matters which it has turned its attention to, while neglecting the larger and more pressing questions It has been pointed out that the Department has exercised itself about the introduction of iron ploughs, of cotton cleaning machines (*ginning* machinery), and has spent time and money in attempting impossible hybridisations of cotton, whilst it has declined to tackle urgent matters such as the indebt [illegible]
the over assessment of the land,
loans for agricultural improvement
Department from such charges, or to say that they have not been justly made, but it is clear to me that the work of the Department has been greatly hindered by three main causes, want of sympathy, imperfect machinery, and want of money I have attempted to prove that the first should not be any longer shown, that the second is capable of improvement, and that, thirdly, the further expenditure of money is an absolute necessity for the accomplishment of any real good. *The future policy and requirements of Agricultural Departments*

What line exactly the Department should take up depends entirely upon the machinery with which it is fitted, and upon the means placed at its disposal I have indicated that I consider that one great problem which will have to be met in the immediate

future is the provision of "Fuel and Fodder Reserves," in order to supply wood to take the place of dung as fuel, and so to set free the dung for its proper use as manure to the land I have also expressed an opinion that a share in the management of loans (*taccavi* system) for digging wells and for other agricultural improvements might with advantage be entrusted to the Agricultural Department, and that the Department should have power to enquire into cases of over-assessment, and to recommend exemption from assessment in special cases, in order to encourage the carrying out of agricultural improvements But such measures cannot be carried out without a more extended machinery than the Department possesses and without its having placed at its disposal considerably larger means than in the past. That a larger expenditure is warranted I fully believe, and I am confident that the outcome will be the bettering of the condition of the agricultural classes, and the increase of revenue to the State.

In conclusion, I would urge once more the need of having uniformity and continuity of policy In a country like India, where conditions are so diversified, there must of necessity be differences of method in the working out of any policy, and these methods may have to be altered according as the conditions alter. But there should be uniformity of general principle, and one policy alike should characterise the action of Agricultural Departments, both Imperial and Provincial.

CONCLUSIONS.

CONCLUSIONS

545. In order that Agricultural Departments may be equipped with the right kind of men to carry out the agricultural improvements which have been suggested in this Report, it is very desirable that more attention should be given to the early training in a scientific direction of future Civil Servants, and that, on their arrival in India, they should have more opportunities of acquainting themselves with the agricultural conditions of the country This will be best effected by giving more weight to Natural Science at the open competition and at the final examination, and by drafting a certain proportion of the men, on arrival in India, into the Department of Land Records and Agriculture Out of those who have distinguished themselves by their proficiency in science, and subsequently by their interest in agriculture, the future Agricultural Directors might advantageously be selected.

The position of Agricultural Director should be invested with some administrative power, and the granting of loans for agricultural improvements should be in part managed by the Agricultural Departments Analyses of districts should be made in respect not only of security from famine, but also of general agricultural conditions and requirements

In order that the work of Agricultural Departments may proceed in the right direction, there are two essentials, (1) a more competent machinery, and (2) an increased expenditure of money upon agricultural improvement.

Lastly, there must be uniformity of principle in the action of Imperial and Provincial Agricultural Departments, and a continuity of policy throughout

RECOMMENDATIONS

RECOMMENDATIONS

546. That more weight be given to Natural Science in the open competitions for the Civil Service, and at the final examination of probationers

That a certain proportion of junior Civilians, on arrival in India, be drafted into Departments of Land Records and Agriculture

That Agricultural Directors be chosen from those men who have distinguished themselves in Natural Science, and subsequently by their interest in Agriculture.

Conclusions.

That Agricultural Directors be given some administrative powers, and that a share in the management of Loans for Agricultural Improvement be entrusted to Agricultural Departments.

That a considerably increased amount of money be placed at the disposal of Agricultural Departments for expenditure upon Agricultural Improvement.

APPENDIX.

CONTENTS

Jackson [illegible]

APPENDIX

In this Appendix are given [illegible] manures, feeding materials, and grass [illegible] bringing out some of the points [illegible] of overburdening it, I did not [illegible] the Report. For the purpose of [illegible] in the Report are repeated, and explanatory [illegible]

A. (see Chap V, [illegible])

Composition of Wheat Soils from [illegible] (Punjab).

(Soils dried at 212° F)	No. 1 From Ghaggar bed	No. 2 From Sotar Valley	No. 3 From [illegible]
* Organic Matter and combined Water	[illegible]	2·77	[illegible]
Oxide of Iron	2·58	4·[illegible]	[illegible]
Alumina	1·72	[illegible]	[illegible]
Carbonate of Lime	2·9[illegible]	2·77	[illegible]
Magnesia	1·07	1·27	1·07
Potash	·30	·71	·31
Soda	·16	[illegible]	·11
Phosphoric Acid	·17	·22	·19
Insoluble Silicates and Sand	90·33	81·57	[illegible]
	100·00	100·00	100·00
* Containing Nitrogen	·07	·02	trace
Equal to Ammonia	·08	·02	trace

No 1 is soil from the bed of the Ghaggar, a stream which is crossed on the journey between Kalka and Umballa In the lower part of the course the bed is sandy The soil was light-coloured, containing much fine sand with micaceous particles

No 2 is soil from the Sotar Valley, which seems to have been formerly the bed of the Ghaggar, the bottom is firm and even heavy soil It is reckoned to be the best soil in Sirsa The sample analysed was free from mica, and was not nearly as fine and sandy as No 1

No 3 is a soil called *Rousli*, a name applied in Delhi and the North-West generally to any sandy loam It is very like No 1, but is even finer and more sandy

[illegible] of these soils are that they are well [illegible]

however, both of vegetable matter and of nitrogen will, I consider, be very necessary in all three cases. Green-manuring, or the use of cattle-dung or similar nitrogenous organic materials, will be the best means of supplying the deficiency

(For further remarks *see* Chap V, paragraphs 58—68.)

B. (*see* Chap. V, paragraphs 63—68.)

Composition of Coffee Soils from Munjerabad, Mysore.

(Soils dried at 212° F)	No 1.	No 2.	No 3
* Organic Matter and combined Water	7 15	13 73	13 30
Protoxide of Iron	trace	1 54	2 54
Peroxide of Iron	5 04	11 83	12 02
Alumina	20 39	11 53	13 81
Lime	·20	32	·32
Magnesia	28	·32	30
Potash	·25	·10	·10
Soda	12	·12	[illegible]
Phosphoric Acid	13	·15	
Sulphuric Acid	03	02	
Nitric Acid	—	—	—
Chlorine	·01	—	
Insoluble Silicates and Sand	66 40	60 34	
	100 00	100 00	[illegible]
* Containing Nitrogen	032	20	
Equal to Ammonia	039	24	

No 1. Hindiganhulla Ida Munoo, considered good coffee soil

No 2 Bartohinhulla, Upper Toddyman's field, where coffee does well.

No 3 Bartohinhulla, Kemp Munoo, from Nui Gondas Heetloo, where does not do well

(For further remarks *see* Chap V, paragraphs 63—68, and Chap XI paragraph 363)

C [illegible]

C [illegible]

Composition of Two Sa[illegible]
from Rawalp[illegible]

	[illegible]
	Grains per [illegible]
Total Solid Residue (at 130° F)	[illegible]
Containing—	
Oxide of Iron and Alumina	—
Lime	[illegible]
Magnesia	[illegible]
Potash	[illegible]
Soda	[illegible]
Chlorine	[illegible]
Phosphoric Acid	[illegible]
Nitric Acid	[illegible]
Sulphuric Acid	[illegible]
Soluble Silica	[illegible]
Free Ammonia	[illegible]
Albuminoid Ammonia	[illegible]

Combining the above constituents together in [illegible] they are probably present in the waters, th[illegible] samples may be represented as follows —

—	Well Water	[illegible]
	Grains per gallon	[illegible]
Carbonate of Lime	4 09	[illegible]
Carbonate of Magnesia	13 23	[illegible]
Carbonate of Soda	16 41	[illegible]
Carbonate of Potash	—	[illegible]
Sulphate of Lime	10 71	[illegible]
Phosphate of Lime	1 59	[illegible]
Nitrate of Potassium	59	[illegible]
Chloride of Sodium	14 69	—
Nitrate of Soda	8 66	—
Oxide of Iron and Alumina	—	[illegible]
Soluble Silica	1 96	[illegible]
Total Solid Constituents	71 93 { grains per gallon	[illegible] { [illegible]
Free Ammonia	002	[illegible]
Albuminoid Ammonia	005	[illegible]

(For detailed remarks on the above analyses see Chap VI, paragraph [illegible])

D. (*see* Chap. VII, paragraph 121.)

Composition of Indian Cattle-dung.

[Solid Droppings of Cattle.]

—	Dung from Lean Cattle (air-dried)	Dung from grain-fed Cart (*bandy*) Bullocks (air-dried)
Moisture	19 59	17 86
* Organic Matter	59 26	61 89
† Mineral Matter (ash)	21 15	20·25
	100·00	100·00
* Containing Nitrogen	1 34	1 08
Equal to Ammonia	1 62	1 31
† Containing		
Insoluble Siliceous Matter	14 43	16 75
Oxide of Iron and Alumina	3 30	1·36
Lime	1·04	85
Magnesia	·44	·30
Potash	1 16	60
Soda	34	26
Phosphoric Acid	47	54
Equal to tribasic Phosphate of Lime	1 03	1 18

(For detailed remarks on above *see Chap. VII*, *paragraph 121*)

E. (*see* Chap. VII, paragraph 121.)

Composition of Ashes of Indian Cattle-dung, after burning.

Moisture	2 04
* *Organic Matter*	2 40
Oxide of Iron and Alumina	9 26
† Phosphoric Acid	1 37
Lime	1·76
‡ Alkalies, Magnesia, etc.	2 97
Insoluble Siliceous Matter	80·20
	100 00
* Containing Nitrogen	·17
Equal to Ammonia	·20
† Equal to tribasic Phosphate of Lime	2 93
‡ Containing Potash	2 05

F. (*see* Chap. VII. paragraph 146)

Composition of Drainings from Manure heap (*gobra tips*) taken at Munjerabad, Mysore.

Water and Volatile Matters	97·29		
Non-volatile Organic Matters	1·23	2·71	Total Solid Residue
* Mineral Matter (ash)	1·48		
	100·00		
Total Nitrogen	·141		
Equal to Ammonia	·171		
* Containing –			
Silica	·316		
Oxide of Iron and Alumina	·213		
Lime	·075		
Magnesia	·039		
Potash	·426		
Soda	·029		
Phosphoric Acid	·050		
Equal to tribasic Phosphate of Lime	·110		
Specific gravity at 60° F.	1·025		

A standard English analysis of Drainings from Manure heaps (Johnston and Cameron's Elements of Agricultural Chemistry and Geology, page 330) gives the following figures —

In 100 Parts	Parts
Total Solid Residue	1·939
Containing Chloride and Carbonate of Potash	·511
" Phosphates of Lime and Iron	·104
Total Nitrogen	·044

Thus, the Drainings from the Indian Manure heap were slightly richer

England

G. (*see* Chap VII, paragraph 146.)

Composition of the Urine of Lean Cattle and Grain-fed Cart (*bandy*) Bullocks

——	Lean Cattle	Cart Bullocks
Water and Volatile Matters	91·77	90·62
Non-volatile Organic Matters	5·29	7·64
* Mineral Matter (ash)	2·94	1·74
	100·00	100·00
Total Nitrogen	·956	1·168
Equal to Ammonia	1·161	1·418
* Containing-		
Silica	·004	·010
Lime	·161	·080
Magnesia	·249	·570
Potash	1·523	·643
Soda	·050	·020
Phosphoric Acid	·022	·022

(For detailed remarks *see* Chap VII, paragraph 146)

D. (*see* Chap. VII, paragraph 121.)

Composition of Indian Cattle-dung.

[Solid Droppings of Cattle.]

—	Dung from Lean Cattle (air-dried)	Dung from grain fed Cart (*bandy*) Bullocks (air dried)
Moisture . .	19 59	17 86
* Organic Matter	59 26	61 89
† Mineral Matter (ash)	21 15	20 25
	100 00	100 00
* Containing Nitrogen .	1 34	1 08
Equal to Ammonia	1 62	1 31
† Containing		
Insoluble Siliceous Matter .	14 43	16 75
Oxide of Iron and Alumina	3 36	1 36
Lime .	1·04	85
Magnesia .	44	·30
Potash .	1 16	68
Soda .	34	26
Phosphoric Acid	47	54
Equal to tribasic Phosphate of Lime .	1 03	1 18

(For detailed remarks on above *see* Chap VII, paragraph 121)

E. (*see* Chap VII, paragraph 121)

Composition of Ashes of Indian Cattle-dung, after burning

Moisture	2 04
* Organic Matter	2 40
Oxide of Iron and Alumina . .	9 26
† Phosphoric Acid	1 37
Lime	1 76
‡ Alkalies Magnesia etc . .	2 97
Insoluble Siliceous Matter	80 20
	100·00

* Containing Nitrogen 17

Equal to Ammonia . . . . . . ·20

† Equal to tribasic Phosphate of Lime . . . 2 93

‡ Containing Potash 2 05

K. (*see* Chap. VII, paragraph 127.)

Composition of Indian Feeding-stuffs for Cattle

	Earth-nut Cake		Gingelly or Til seed Cake	Niger seed Cake	*Hongay bran* (*Pongamia glabra*)
	(Decorticated)	(Undecorticated)			
Moisture .	8.10	9.80	8.03	11.90	9.58
Oil .	7.26	6.50	13.01	6.43	9.23
* Albuminous Compounds .	47.81	47.31	38.92	34.01	24.93
Carbohydrates Digestible Fibre etc	25.02	19.8	22.12	22.27	47.42
Woody Fibre .	4.86	10.26	4.70	17.14	4.70
† Mineral Matter (ash)	6.95	6.85	13.22	8.25	4.14
	100.00	100.00	100.00	100.00	100.00
* Containing Nitrogen	7.65	7.57	6.22	5.44	3.99
† Including sand	3.25	—	2.89	1.25	—

	Mahua (*Bassia latifolia*) refuse from Distillery
Moisture .	17.92
Oil . .	.46
* Albuminous Compounds	3.44
Gum, Mucilage etc	3.08
Sugar . .	64.40
Digestible Fibre .	3.14
Woody Fibre .	2.13
† Mineral Matter (ash)	5.43
	100.00
* Containing Nitrogen	.55
† Including sand	2.90

The large amount of sugar in the *Mahua* refuse is noticeable

L. (*see* Chap. VII, paragraph 136.)
Composition of Indian Bone-meals.

	1. (Pure)	2 (Pure.)	3 (Adulterated)	4. (Adulterated.)
Moisture	8 50	7 76	6 50	7 32
* Organic Matter	28 85	29 33	18·75	23 43
† Phosphoric Acid	25 00	24 08	18 15	22 08
Lime	33 70	32 56	37·55	33 88
Magnesia, Alkalies, etc	} 3 16 {	1 03	3·24	2 36
‡ Carbonic Acid		3 00	11·80	7 15
Insoluble Siliceous matter	·40	2 24	4 01	3 78
	100 00	100 00	100 00	100·00
* Containing Nitrogen	4 12	4·04	2·78	3 35
Equal to Ammonia	5 00	4 90	3 38	4 07
† Equal to tribasic Phosphate of Lime.	54 58	52 83	39 62	48 21
‡ Equal to Carbonate of Lime	—	6 82	26 82	16 25

M (*see* Chap. VII, paragraph 139.)
Composition of Materials used to adulterate Indian Bone-meal.
(Samples taken at Mazagon Dock, Bombay, 10th January 1891.)

	A	B	C.
Moisture	3 29	—	4·37
Lime	43 78	33 23	40 13
Magnesia	1 35	—	20·00
Oxide of Iron and Alumina	4 78	7 65	2 30
* Carbonic Acid	29 64	24 61	28 55
Alkalies, etc	4 70	5 83	4·05
Insoluble Siliceous Matter	12 46	28 65	·30
	100 00	100·00	100 00
* Equal to Carbonate of Lime	67 36	56 00	64 89

A Grey-coloured.
B. Shell-sand
C White Probably powdered magnesian limestone.

N. (*see* Chap XIV, paragraph 383)

MECHANICAL ANALYSES of Samples of Indian Wheat taken from Threshing-floors of Cultivators in the Cawnpore district.

In chapter XIV, paragraph 383 I have given a table setting out the percentages of the various kinds of impurities found in six samples of wheat collected for me from threshing floors of cultivators and cleaned in my presence

It may be convenient however, in addition to stating the impurities under each heading according as they happen to be large seeds and lumps of earth, or chaff, or small seeds and fine earth etc, to give the impurities under the headings that are recognized by the London Corn Trade Association

No	Village	Barley, etc*	Dirt †	Total other than Wheat
		per cent	per cent	per cent
1	Binaitpur	072	·054	1·26
2	Cawnpore	1·06	600	1 6 0
3	Gotaja .	1 120	500	1 710
4	Likhampur .	1 010	1 010	2·020
5	Rawatpur	390	·280	670
6	Nawabganj .	660	540	1·200
	Average	720	512	1·232

* The term ' barley etc includes all grain of intrinsic value such as barley, peas linseed etc

† The term ' dirt includes earth, chaff and miscellaneous weed seeds

No	——	Barley etc	Dirt	Total other than Wheat
		per cent	per cent	per cent
7	Bulk in Cawnpore Market	2·71	92	3 63

(For further details *see* Chap XIV paragraphs 383—4)

L. (*see* Chap VII, paragraph 186)

Composition of Indian Bone-meals

	1 (Pure)	2 (Pure)	3 (Adulterated)	4 (Adulterated)
Moisture	8 50	7 76	6 60	7 32
* Organic Matter	28 85	29 33	18 75	23 43
† Phosphoric Acid	25 00	24 03	18 16	22 08
Lime	33·79	32 56	37 55	33 88
Magnesia Alkalies, etc	3 46 (Magnesia, Alkalies, etc. and Carbonic Acid together)	1 03	3·24	2 36
‡ Carbonic Acid		3 00	11·80	7 15
Insoluble Siliceous matter	40	2 24	4 01	3 78
	100 00	100 00	100 00	100 00
* Containing Nitrogen	4 12	4 04	2·78	3 35
Equal to Ammonia	5 00	4 90	3 38	4 07
† Equal to tribasic Phosphate of Lime	54 58	52 83	39 62	48 21
‡ Equal to Carbonate of Lime	—	6 82	26 82	16 25

M (*see* Chap VII, paragraph 189)

Composition of Materials used to adulterate Indian Bone-meal. (Samples taken at Mazagon Dock Bombay, 10th January 1891)

	A	B	C
Moisture	3 29	—	4 37
Lime	43 78	33 23	40 43
Magnesia	1 35	—	20·00
Oxide of Iron and Alumina	4 78	7 65	2 30
* Carbonic Acid	29 64	21 64	28 55
Alkalies, etc	4 70	5 83	4 05
Insoluble Siliceous Matter	12 46	28 65	30
	100 00	100·00	100 00
* Equal to Carbonate of Lime	67 36	56 00	64 89

A Grey-coloured
B Shell sand
C White Probably powdered magnesian limestone

N. (*see* Chap. XIV, paragraph 383.)

Mechanical Analyses of Samples of Indian Wheat taken from Threshing-floors of Cultivators in the Cawnpore district.

In chapter XIV, paragraph 383 I have given a table setting out the percentages of the various kinds of impurities found in six samples of wheat collected for me from threshing-floors of cultivators and cleaned in my presence.

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No.	Village	Barley, etc *	Dirt †	Total other than Wheat
		per cent	per cent	per cent
1	Binaitpur	072	·054	·126
2	Cawnpore .	1·06	600	1 660
3	Gotaya . .	1 120	590	1 710
4	Likhanpur . .	1·010	1 010	2·020
5	Rawatpur .	390	280	670
6	Nawabganj . .	660	540	1·200
	Average	720	512	1·232

* The term ' barley, etc , includes all grain of intrinsic value, such as barley, peas, linseed, etc

† The term " dirt includes earth, chaff, and miscellaneous weed seeds

No	—	Barley, etc.	Dirt.	Total other than Wheat.
		per cent	per cent	per cent
7	Bulk in Cawnpore Market . . .	2 71	·92	3 63

(For further details *see* Chap XIV, paragraphs 383—4)

O. (*see* Chap. XIV, paragraph 388.)

Mechanical Analyses of Samples of Linseed taken from Cultivators' Stores and threshing-floors

Mechanical Analyses of 18 Samples of Linseed from Bilaspur district Central Provinces.

No of sample	Whence taken	Impurities removed by sieving		Impurities removed by hand picking	
		Sieved Linseed	Impurities	Pure Linseed.	Total Impurities
		per cent	per cent	per cent	per cent.
1	From threshing floor .	95·62	4·38	94·49	5·51
2	store in house	90·21	9·79	87·70	12·30
3	,, threshing floor	96·18	3·82	94·26	5·74
4	,, ,,	94·17	5·83	92·89	7·11
6	,, store in house	97·07	2·93	95·81	4·19
6	,,	93·83	6·17	92·07	7·93
7	,, ,,	90·08	9·92	87·88	12·12
8	,, ,, ,,	95·35	4·65	93·61	6·39
9	,, ,,	95·33	4·67	93·10	6·90
10	,, ,, ,,	91·37	8·63	89·83	10·17
11	,,	94·31	5·69	92·93	7·07
12		94·24	5·76	92·81	7·19
13	,, ,, .	94·72	5·28	93·12	6·88
14	,, ,,	96·03	3·97	94·18	5·82
15	,, ,,	92·12	7·88	89·33	10·67
16	,, ,,	96·29	3·71	95·52	4·48
17	,, ,,	96·28	3·72	95·36	4·64
18	,,	97·86	2·14	96·66	3·34
		Average .		92·87	7·13

Mechanical Analyses of Four Samples of Linseed from Raipur district, Central Provinces

No of sample	Whence taken	Impurities removed by sieving		Impurities removed by hand picking	
		Sieved Linseed	Impurities	Pure Linseed	Total Impurities
		per cent.	per cent	per cent.	per cent.
119	Consignment to a Trader	98·53	1·47	97·77	2·23
20	Raipur market	94·88	5·12	92·85	7·15
21	,, ,,	93·59	6·41	91·97	8·03
22	,, ,,	95·07	4·93	93·16	6·84
		Average		93·94	6·06

Mechanical Analyses of Two Samples of Linseed from Jubbulpore district, Central Provinces.

No of sample.	Whence taken	Impurities removed by sieving		Impurities removed by hand-picking	
		Sieved Linseed	Impurities	Pure Linseed	Total Impurities
		per cent	per cent	per cent	per cent
23	. . . .	96 38	3 62	94 89	5 11
24	. . . .	97 20	2 80	96 72	3 28
		Average . .		95 81	4 19

Mechanical Analyses of Two Samples of Linseed from Damoh district, Central Provinces

25		94 45	5 55	92 84	7 16
26		94·21	5 79	90·36	9 64
		Average		91 60	8 40

Mechanical Analyses of 11 Samples of Linseed from Nagpur district, Central Provinces

27	Stored in house .	96 33	3 67	94 97	5 03
28	" .	97 22	2 78	96 24	3 76
29	From threshing floor	99 00	1 00	98 10	1 90
30	Stored in house	98 00	2 00	96 76	3 24
31	Brought to Ralli Brothers store .	98 19	1 81	97 34	2 66
32	From threshing floor	96 46	3 54	94 61	5 39
33	" "	97 20	2 80	96 05	3 95
34	" "	95 12	4 88	91 44	8 56
35	" "	96 70	3 30	94 51	5 49
36	" "	96 59	3 41	95 02	4 98
37	" "	99 15	85	98 60	1 40
		Average		95 79	4 21

SUMMARY.

Average of Samples from all the Five Districts	94 per cent. Pure Linseed	6 per cent. Total Impurities

MY TOURS, 1889-90. TOURS.

(*See* Map of Tours)

Arrival in India, December 10th 1889
First Tour . Dec 10th 1889 to May 19th 1890
Second Tour . July 14th 1890 to Sept 12th 1890
Third Tour Nov. 23rd 1890 to Jan. 10th 1891.

Departure from India, Jan 10th 1891. First Tour
Residence in India, 13 months.

NOTE —*The references in the following account are to* PARAGRAPHS *in the foregoing Report*

First Tour, Dec. 10th 1889 to May 19th 1890. 1889:

ON November 21st 1889 and within a week from the time that my delegation to India was decided upon I left London for Marseilles, and at the London, Nov. 21. latter port joined the Peninsular and Oriental Company's steamship Marseilles Nov 23 'Bokhara, the vessel which singularly enough had conveyed Sir James Caird to India when he went out in October 1878 as one of the Famine Commissioners Hardly was I on board before I came in close and [illegible] with Indian agriculture in the person of Mr R H [illegible] m I had previously known as a Scotch [illegible] his way to his coffee estates in Mysore [illegible] felt in the progress of agriculture in India, and in any movement for its improvement, rendered our meeting an invaluable assistance to me, and one which I had reason throughout my tour to be extremely glad of Our daily conversations, and a study of the 'Statistical Atlas of India (a copy of which Sir Charles Bernard had kindly lent me) soon convinced me that I had before me a difficult and responsible task On board the 'Bokhara" I met Mr Justice Jardine of the High Court, Bombay, Mr Harvey James, Secretary to the Government of India in the Legislative Department Dr Warburton (Kapurthala), Mr H F Brown (Kilburn & Co Calcutta) Mr Apperley (indigo planter, Bettia) one or two tea planters, a Punjab irrigation officer, Mr Oldham (late of the Public Works Department) and others more or less connected with Government Departments or with agriculture

On coming within sight of Bombay I received a cordial invitation from Bombay, Dec 10 Lord Reay, the Governor of Bombay, to go direct to Government House Malabar Point Here, in addition to the Governor, I met Mr Ozanne, Director of the Bombay Department of Agriculture, and Dr Theodore Cooke Principal of the College of Science Poona At an informal meeting next day with these gentlemen, Mr Elliot, and Mr Bhimbhai, Assistant Director of Agriculture, Bombay, we discussed the general points to which my attention would specially be directed during my tour

On December 12th I travelled with Dr Cooke to Poona, and there met Poona, Dec 12. Mr Howman who had come over from England in order to introduce the mechanical 'cream separator and English systems of butter-making (para 264) December 13th was spent in going over the College of Science (para. 520), and the Experimental Farm (para 483) attached to the College Returning to Bombay, I left again on the evening of December 14th for Pachora, Mr Bhimbhai accompanying me We were met at Pachora by Mr P. R Mehta, a former student and diploma holder of Cirencester College, now the Superintendent of the Bhadgaon Experimental Farm

Bhadgaon, Dec. 15. I inspected the Bhadgaon Farm (para 482) that day, seeing the cold-weather (*rabi*) crops, and the Mysore herd of cattle I left the following morning, having received directions to proceed at once to Calcutta to meet Sir Edward Buck, Secretary of the Imperial Agricultural Department

Calcutta Dec 18—22 before he went on tour Arrived at Calcutta I spent from the 18th inst to the 22nd inst in making ' officials of the Agricultural Departm ntatives of commercial houses more or l Excellency the Viceroy (the Marquis o an interview, and I met also at Member of Council for the Agricultural Department, Colonel Ardagh, Private Secretary to the Viceroy, Mr Harvey James, Mr Finucane, Director of Agriculture, Bengal Presidency, Dr W King, Director of the Geological Survey, Dr George King, Director of the Botanical Gardens, Mr Muir Mackenzie Under Secretary, Agricultural Department, Government of India, Mr J E O'Conor, of the Financial Department, as well as Mr N Banerji and Mr N G Mookerjee, of the Bengal Agricultural Department, two Natives who had previously been students at Cirencester College

Messrs Octavius Steel & Co kindly gave me information in regard to the use of improved agricultural machinery, Mr Ross (Kelly & Co) as to the trade in and conditions of export of wheat and oil-seeds, Messrs Mackillican & Co and Messrs. Kilburn & Co as to the trade in bones and other manures

Sir Edward Buck was at this time about to leave Calcutta on a tour in part of the North-West ... Agra, Gwalior, and Indore, to Berar, ... ' iras As the Cawnpore district, to ... which Sir Edward had previously served, he thought it would be of advantage to me if I accompanied him, and this I was very glad to do Mr H. C Hill, then Officiating Inspector General of Forests, was also of the party The first

Cawnpore, Dec 24 halt was at Cawnpore, reached on December 24th, and here we met Mr F. N Wright, Collector of Cawnpore, Mr W B Wishart, Secretary Upper India Chamber of Commerce, and Mr Muhammad Husain, Assistant Director of Land Records and Agriculture, North-West Provinces and Oudh The greater part of the day was taken up in examining the experiments which were being tried on reclaiming sterile salty land (*usar*) at two places near Cawnpore The first was the Jubi enclosure (para 75), and the second the Amramau farm (para 75). A brief visit was also paid to the Cawnpore Experimental Farm (para. 478),

Bilhaur Dec 24 and in the evening we pushed on to Bilhaur, where we went into

In camp, Dec 24—28 camp For the next few days we constantly shifted our quarters, moving from village to village, and in the course of our march I was enabled to get a capital view of the agriculture of this district of the North-West Provinces, and to gain from Sir Edward Buck much that was the result of his own experience as a district officer in these parts The cold-weather (*rabi*) crops were then on the ground, including a good deal of wheat, and we also went over large stretches of salt-destroyed plains (*usar*) land Besides this, I had the opportunity of seeing, at the different halting places, the village records and maps of the village accountants (*patwaris*), and of learning how the Land Record system was maintained in these Provinces Among the places at which we stopped were Aima, Sauda, and Kairnagar On the morning of December 28th I left the camp, and, in company with Mr Muhammad Husain, rode back to Bilhaur, and thence went by train to Cawnpore, where I made a close inspection of the Cawnpore Experimental

Cawnpore Dec. 29 ... 286) attached to it On the

Etawah, Dec 30 ... me with him to Etawah, to ... ming ravine land along the ... "Fuel and Fodder Reserve"

Aligarh, Dec 31 (paras 70 and 151) We then journeyed to Aligarh going, on December 31st, to the Chherat Farm (para 75), where we saw the experiments which Mr

1890. Muhammad Husain had been conducting on the reclamation of salty land

Agra, Jan 1—3 (*usar*). This done, we made a short stay at Agra, and I again met Sir

Edward Buck, and travelled on with him to Jhansi. We stayed with Mr. Lang, the Commissioner of Jhansi, and early on the morning of January 4th set out for Laksha, in order to go over some of the rough hilly country overlooking Jhansi, on which efforts at reclamation had been made. This had been done by embanking the land, and thus preventing the rush of water down the sloping side, the endeavour has been made also to grow trees and grass, as well as to hold up water for irrigation purposes (para 70) Jhansi, Jan. 4.

From Jhansi we passed by rail through the fertile Nerbudda Valley then bearing rich crops of wheat and oil seeds, and on to Indore, where we halted a day. We left on the 6th inst. for Akola, in Berar, where we again met Mr H. C. Hill. I saw here the cultivation on the rich black cotton-soil which abounds in these parts. Indore, Jan 5–6 Akola, Jan 7–9.

From Akola we went, on January 9th, to Poona, *vid* Bombay, and at Poona I parted company with Sir Edward Buck, he proceeding to Hyderabad, whilst I was to journey on with Mr Hill towards Mysore and Coorg.

During a short halt at Poona I again visited, on January 11th, the Poona College, and in company with Mr Woodrow (the Professor of Agriculture) and Mr Dadina (the manager) the Poona Experimental Farm. The same evening I started off with Mr Hill and Mr Dickinson (lately Deputy Conservator of the Coorg Forests) on a tour which was to take me through the Coorg Forests, and to give me some idea of the working of a forest and of the Poona, Jan. 11
... We travelled by rail through
... arwar, and Hubli, into
... a short stay here, we Bangalore, Jan 13
... th inst On the 15th we
... camp being joined by Mysore, Jan 14.
... orests At Hunsur I Hunsur Jan. 15.
... rnment, and also the
... para 161) Our route
... ern Forests, and taking Coorg Forests, Jan 15–22.
... I had a capital oppor
... , the establishment of
plantations, the spread of forests by the securing of natural reproduction, the system of protection by means of fire lines, and the methods of exploiting timber. Teak (*Tectona grandis*) and *Honne* (*Pterocarpus marsupium*) were the most valuable trees grown as well as bamboos.

From Mr Hill I heard a good deal about the Forest School at Dehra Dun, where the native forest subordinates are trained, and which I visited at a later date. We camped on the 16th at Murkal, in the eastern zone of the Hutugat Forest, and the following day rode into the middle zone. On the 18th we passed into the Nalkeri Forest, and encamped at Nagerholé. Here I saw a sandal-wood plantation and, going on next day into the middle and western zones of the Nalkeri forests, we came across instances of the class of cultivation known as *kumri* which is carried on by the aboriginal forest tribes, the *Karubars*. We encamped again at Nagerholé, and passing on came on the 20th, to Karmad, and halted at Arimame Bassi.
On ... way to which we passed
se ... iends, and accompanied
o ... 22nd, in bullock carts to
m ... meet Mr R H Elliot
a ... he journey was neither
e ... stretch of country I
fi ... met Mr Breithaupt, the
Secretary to the South Coorg Coffee Planters' Association, and was introduced by him to a number of the planters around, they having as it chanced met here on the day of my visit. I was shown over several plantations and saw the picking of the crop and its preparation for market besides which I heard a great deal from the planters as to what were their main requirements and their experience (para. 362 *et seq*). I was most hospitably received and set comfortably on my way, reaching Mercara on the morning of January 23rd. Here Colonel Clarke, Commissioner of Coorg, showed me Polybetta Jan. 22 Mercara, Jan. 23.

much kindness and facilitated very greatly my rather difficult progress through the, to me, unknown country After calling on Mr W. S Sullivan, I found my way on to Mr J S *Trelawney*, at Coover Cooly, where I stayed the night On the 25th I pushed on through Somawarpet and Sanavada Santa to Kodlipet, halting there and fixing up my quarters in a disused schoolroom Thence, after much difficulty, I succeeded in getting my drivers to take me into Mysore territory, and pushed on to Sucrara Santa Here I paid a visit to Mr Butcher, whose coffee plantations I went over, and then proceeded to Suklespoor, halting there for the night The next morning's march (January 27) brought me to my destination, Baricbinhulla, Munjerabad where Mr. Elliot met me, and here I remained until February, 3rd Under Mr Elliot's guidance I went over his different estates and neighbouring ones seeing both the cultivation and the preparation of the coffee for sale (para 363) In this way, and in long conversations on matters concerning Indian agriculture in general, my time was fully and profitably engaged, and the help Mr Elliot gave me then and since was simply invaluable to me On February 3rd I had to leave, and proceeded by way of Chickmanglur and Kadur, the Southern Mahratta Railway, and Bangalore to Madras, which I reached on February 5th. At Madras I was met by Mr C Benson, Assistant Director of the Department of Land Records and Agriculture, with whom I stayed His Excellency the Governor (Lord Connemara) gave me two interviews and I also had others with the Hon Mr (*now Sir Henry*) *Stokes*, and the Hon Mr Garstin, the two Members of Council also with Mr H F Clogstoun, Director of the Department of Land Records and Agriculture, Mr C A Galton, Revenue Secretary, Mr J D Rees, Private Secretary to the Governor, *Mr D Duncan, Acting Director of Public Instruction*, Mr C G. Douglas, Examiner of Forest Accounts, and Mr W Kiese, Acting Principal of the Saidapet College In company with Mr Rees I visited the Saidapet College and Farm on February 6th (paras 523 and 488) Early on the *morning of* February 7th a conference was held at Mr Clogstoun's house, at which, in addition to Mr Clogstoun Mr Benson, Colonel Olcott and myself, several of the leading native landowners were present, among them being Mr S Subramania Iyer, Mr R Ragunatha Row, and Dr M Iyaswami Pillai, also Mr. P Rajaratna Mudliar, and Mr C K Subba Row, Sub-assistant Director of Agriculture In this way I was enabled to get some idea of the most pressing needs of agriculture in Southern India, and to learn in what respects its circumstances differed from those in the more northern parts I started off the same evening with Mr Benson on what was to me a very instructive and enjoyable tour through some of the districts in the southern part of Madras Leaving Madras, we arrived on the morning of February 8th at Shiyali (Tanjore), after crossing the Coleroon river and coming upon the Tanjore delta, where rice was the principal crop then growing At Shiyali we were met by Mr C Sabanayagam Mudliar, who took us over his estate and showed us the rice cultivation upon it (para 317), and his well cared-for bullocks and improved iron *ploughs (para 291) In the evening we continued our journey by train*, arriving next morning at Madura Mr Ramasubba Aiyar, and Mr. Tillanayagam Pillai, the Deputy Collector, the Mayor of the Municipality, and other gentlemen met us and drove us to the farm which formerly belonged to the Madura Farmers' Club (para 480), but of which only the dairy-farming portion was maintained Here our hosts had collected a number of the subordinate revenue officials and of the leading *raiyats*, and with the aid of an interpreter we had a long and, to me most interesting conversation, or rather conference Similar gatherings of this kind were held at other stopping places during the tour, and in this way I was enabled to get much information Mr Benson also had arranged for representative men to come up from some of the more distant parts, such as Tinnevelly which, for want of time, I was unable to visit myself

Munjerabad, Jan. 27—Feb 3. *Madras Feb 6—7* *Shiyali, Feb 8.* *Madura, Feb 9.*

We left Madura in the evening, and, passing by Trichinopoly, traversed the valley of the Cauveri until, gradually rising to the higher ground, we reached Erode, where soil and cultivation began to alter Changing here on to the Madras Railway, we continued to rise until we came, in the afternoon of February 10th, to Mangalam (Avenashi Road) in the

Avenashi, Feb 10—11.

Coimbatore district We were taken to see the "garden" (irrigated [illegible] wells) cultivation, and the system of enclosing fields with hedges (para. 240) Going on to Avanashi itself, we were shown betel-vine [illegible] the folding of sheep and goats on the land (para. 126), the [illegible] of mud from tank beds (para 132), the growing of perennial cotton (para 338), the manufacture of saltpetre (nitre) (para 133), and the breed of Coimbatore sheep. Late in the evening of February 11th we left Avanashi and, while Mr Benson went direct to Salem I struck off alone to [illegible], and thence drove up the hill to Ootacamund, reaching the [illegible] hill station on the morning of the 12th inst. I was unfortunate in not finding Mr Lawson, the Government Botanist, in residence, but I met Mr D. Hooper, the Government Quinologist, and also Major-General [illegible] who told me a good deal about tea growing in the Neilgherries (paras [illegible] and 358) The next morning Mr Hooper took me over the Government cinchona plantations and stores, and also over the Dodabetta Tea Estate I left Ootacamund on the evening of the 13th, and joined Mr. [illegible] at Salem on the 14th Preparations were then being made for an Agricultural Show that was shortly to be held here Mr Benson and I drove out some 10 miles into the country and saw the cultivation both on [illegible] ("dry") land and on that irrigated from "tanks," and that watered by wells ("garden" land) Millets, tobacco, sugar-cane, and many kinds of vegetables were prominent crops, and here I saw the old-fashioned wooden sugar-mills at work (para 287) On our way back I went to see Mr Hooper Deputy Conservator of Forests, and had a conversation with him upon the administration of forests in Madras The same evening I left Salem and returned to Madras on February 15th, where I paid a second visit to the Saidapet College and had an interview with Mr Kiess, the acting Principal, after which His Excellency the Governor gave me a second audience The next day I visited the Hon. Mr Stokes and subsequently Mr Van Gaezel, the Chemical Examiner of Madras, leaving in the evening for Bombay, *en route* for Saugor in the Central Provinces, where I was to meet Mr J B Fuller Commissioner of Settlements and Agriculture, Central Provinces The first portion of the journey took me through the Bellary and Raichur districts, and I arrived at Bombay on the morning of February 18th I employed the day in interviewing commercial men in Bombay and in getting from them information as to the conditions of the trade in wheat (para. 376 *et seq*), oil seeds (para 388), cotton (para. 338), feeding cakes (para 127) bones (para 142), and other manures, as well [illegible] I met Mr John Marshall, Secre[illegible]ce Messrs Finlay, Muir & Co, [illegible] In the evening I left again, going [illegible] which was reached on the morn[illegible]d in camp on the 21st, and [illegible] a great deal of it con[illegible]til the morning of [illegible] successive stages we [illegible] Settlement Officer, [illegible] were wheat, linseed, [illegible] made acquainted with the systems of Land Classification and of Land Settlement (para 46) adopted in these Provinces and I examined in many places the work and maps of the [illegible] and district [illegible] 24th, after p[illegible] to now we had been going over the black soil of the Saugor district but on the 25th we crossed on to the redder soil of the Vindhyan sandstone formation, and arrived at Damoh on the evening of February 27th I took leave of Mr Fuller the next morning and pushed on to Jubbulpore Here I called upon Mr Lindsay Neill Divisional Commissioner, and Colonel Van Someren, Conservator of Forests In the evening I left for Allahabad, arriving at the latter place on the morning of March 2nd I made the acquaintance here of (the late) Mr S A. Hill, of the Muir College, one of the few scientific chemists sent out from England to India. I had a long conversation with Mr Hill relative to the position of

Damoh, Feb. 27

Jubbulpore, March 1

Allahabad, March 2.

scientific men (para 436) and the prospects of Native students becoming workers in chemical science (para 423) The same evening I travelled towards Cawnpore, came there next morning, and went out to the Cawnpore Experimental Farm (para 478) The corn crops were at this time nearly ripe Mr J F Duthie, Director of Botany for Northern India, joined me in the evening, and next morning we went together to the Cawnpore Farm, where I made the acquaintance of Mr T W Holderness, Director of the Department of Land Records and Agriculture, North-West Provinces and Oudh We drove out to the Juhi Reserve and the Amramau Farm to see the experiments carried out on the reclamation of sterile salty land (*usar*) (para 75) In the evening Mr Duthie and I left for Aligarh, where, on 5th March, we carefully inspected the Chherat Farm (para 75), and on 6th March the Gursikran Farm (para 75), at both of which places experiments on salty lands (*usar*) reclamation were being conducted on a large scale, and were kept under botanical observation by Mr. Duthie On 7th March we left Aligarh, Mr Duthie going to Saharanpur and I to Meerut I called on Mr Whiteway, the Collector, and in the afternoon was driven out to see the splendid market garden cultivation carried on around the city by the Jât, Lodha, and Sani castes (para 149) I also was shown over the farm belonging to Rai Bahadur Debi Singh, which was formerly an Experimental Farm of the Agricultural Department of [illegible] Oudh, and on which improved iron ploughs [illegible] The next morning I drove on to the Baboo- [illegible] where there is an Army Remount Depôt, [illegible] ions are carried on Captain Goad, Assist- [illegible] unt Department, took me over the Depôt and Farm, and showed me the horses and the methods of cultivation employed, such as the growing of oats and lucerne, ploughing with iron ploughs drawn by horses instead of bullocks, and the working of wells by horses

Cawnpore March 3–4; Aligarh March 5–6; Meerut March 7

Leaving Hapur on the morning of 9th March, I returned to Meerut, and then went on to Delhi, where I spent a day seeing the sights, and left again on the morning of the 11th for Saharanpur Arrived there, I met Mr Duthie and also Mr Patterson, the Collector On 12th March Mr Gollan, the Superintendent, took me over the Saharanpur Botanical Gardens (para 479) and in the afternoon we went to the Saharanpur Agricultural Show (para 541), which was specially interesting to me as being the first of the kind I had seen in India At the invitation of Colonel Dean, Superintendent of the Army Remount Department, I saw the Saharanpur Depôt on the morning of the 13th, the horses here being principally Australian horses ("Walers") imported for the use of medium cavalry and field artillery Colonel Dean also drove me over the adjoining farm, lucerne and oats, as at Hapur being largely grown After this I posted from Saharanpur to Dehra Dun, reaching the latter in the evening, and going to Mr F Fernandez, then Deputy Director of the Forest School The next morning I called on Colonel Bailey, the Director, and shortly afterwards Mr H C Hill, Officiating Inspector General of Forests, arrived The sessional examinations of the Forest School were in progress at this time, and as these were the first ones I took the opportunity afforded me of attending them, and of ascertaining in some measure what the standard of teaching attained in the Forest School was (para 526). Mr C Bagshaw, Conservator of Forests, Central Circle, North-West Provinces, (the late) Mr W E D'Arcy, Assistant Inspector General of Forests, Mr L Mercer, Deputy Conservator (Dehra Dun district), and Mr A Smythies Instructor of the Forest School, were present, in addition to Colonel Bailey, Mr Hill, Mr. Fernandez, and myself I attended the examinations for four successive days, and was allowed to question a number of the candidates in chemistry and in vegetable morphology (para 526) I also went over the school buildings, chemical laboratory and museums [illegible] March I left Dehra [illegible] back to Saharanpur, and [illegible] al Show was [illegible] e ploughing [illegible] iteway, and [illegible] he 20th, and [illegible] the Museum

Delhi, March 9–10; Saharanpur March 11–13; Dehra Dun March 13–18; Meerut March 19–20; Saharanpur, March 21–23

and Herbarium and being taken by Mr Gollan to see the cultivation of the neighbourhood, which was largely market-gardening of a high class the cultivators being principally Sênis At Saharanpur I met Mr Benson, the District Judge, at whose house I was staying, and who was brother of the Assistant Director of Agriculture, Madras, also Mr W Ward Smith Executive Engineer, Eastern Jumna Canal, from whom I learnt much about the irrigation system of the North West Provinces On 24th March, at Mr Ward Smith's suggestion I t
Mr King, the E
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great works by

Lucknow, March 26

Cawnpore and district March 27—April 2

Rura March 31

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Garaul, Apr 16

Mozufferpore Apr 17

instant a visit was paid to the Jaipur Estate, Motipore, then managed by Mr H Abbott, and here Mr Wishart and I stayed a couple of days, returning to Mozufferpore on the evening of the 9th On the 11th instant we went to see the Bhicanpur factory and estate of Mr G Richardson comprising, in all 7 000 acres In the evening I set off alone to make my way to Pupri in the Durbhanga district which I reached next day after riding 30 miles Motipore, April 8—9 Bhicanpur April 11 Pupri Apr 12 13

Serowlie, April 14–16 at Mr J J Macleod's estate (Lall Seriah), of Native students becoming
spent two days here, and saw the cultivation The same evening I travelled
lying factories on the estate were visited, and I went out to the Cawnpore
Dhobrah (Mr H Apperley) On the afternoons were at this time nearly
Motihar, April 17 Motihari, where on the following day there was Northern India, joined me
Light Horse Here again I met a large number to the Cawnpore Farm,
districts around, as well as Mr W. D Blyth, Holderness, Director of the
Pepra April 18 engineer From Motihari we went on the evening North-West Provinces
Seeraha April 19 and stopped at Mr Wyatt's factory On the 18th the Amraman Farm,
Mr W B Hudson's at Seeraha, and went over his on of sterile salty land
Bheea April 20 following, leaving in the evening for Bara (Mr Gale I left for Aligarh,
to Bebeea, where I parted company with Mr Macl at Farm (para 75),
and paid another short visit to Messrs Thomson and Mylnth of which places
Allahabad April 22–24 of the 21st I took the train to Allahabad, and, arriving there conducted on
met Mr A J Hughes, Supervising Municipal Engineer, by Mr. Duthie
inces and Oudh It had been arranged, with the consent of Saranpur and I
of India, *that I should visit certain towns in the North-West Prov* the after
it was proposed to introduce new water supplies and sewerage soon carried
I was to report upon these from a chemical and agricultural point of I also
I had originally intended to make a short tour in the Punjab after my return
from *Tirhoot*, but I found the season too far advanced to permit of this, the
cold season (*rabi*) crops being already off the land Consequently I adopted
the alternative plan and visited in succession Allahabad Cawnpore
Benares and lastly Naini Tal At Allahabad on April 22nd in company
with Mr Hughes, I saw the new waterworks then in course of construction
In the afternoon I was shown over the Allahabad Grass Farm by Col Depôt
Marriott of the Commissariat Department (para. 215 *et seq*), and he explained
to me the system on which the Farm is worked Grass was then being cut
and put into silos (para 224) On the morning of the 23rd I examined
with Mr Edmonson, the sanitary officer, the system of town-cleansing the
trenching of night-soil upon land at Futtepore Bichwra (para 149), some little
distance out of the town, and another site at Naini which it was proposed to
utilise for a sewage farm At Allahabad I met again Mr S A Hill, also
Mr F. W Porter, the Collector, and Dr Hall Superintendent of the *Gaol*
I went with Mr Hughes on the morning of the 24th to see the pumping
station and new intake from the Jumna After this I left Allahabad and
travelled with Captain F C Chapman to Bharwari on the East Indian Railway,
from which place we drove on the Captain Chapman's Estate at Bâti crossing
Bâti April 24–26 the Ganges shortly before coming to our destination The Estate is in the
Province of Oudh, and comprises about 13,000 acres situated along the banks
of the Ganges Here I saw how Captain Chapman, by making a vast embankment and keeping out the Ganges, as well as by draining and pumping had
succeeded in reclaiming and cultivating a large amount of land that was
formerly a lake (para 71) The steam plough was then at work on a portion
still unreclaimed (para 281) *A good deal of ravine land was also reclaimed*
by terracing and by keeping back surface flow of water (para 70) Two days
were spent here in riding over the property and seeing the villages included
in it and also their cultivation I travelled to Cawnpore on the evening of
Cawnpore April 27–May 1 *the 26th April, and put up at Mr Wishart's* The next morning I went with
Mr Wishart to the *bazar*, and took samples of wheat, the different impurities
in which were subsequently separated out for me and determined in Mr
Wishart's office (para 384) We then drove to the canal side and saw the
plot of land called "Buck Sahib's village," on which *Kachhi* cultivators use
the town refuse and after that to other land outside Cawnpore where night-soil was being trenched (para 149).

On the 28th I went over some cotton mills and on the 29th inspected, with Mr. Hughes, the proposed intake of water from the Ganges, after which I met Mr Walter Butler (engineer), Mr F N Wright (the Collector), Major Caddeley, of the Army Harness Factory, Dr Cordon (civil surgeon), and Mr J Rogers (engineer) The next day Mr G B Allen took me over Messrs Cooper, Allen & Co's Army Boot Factory, and then I went on to the Cawnpore Experimental Farm The next day, after inspecting the site for a proposed sewage farm Major Caddeley took me to see the Army Harness

and Herbarium, and being taken by Colonel Worsley and I walked over the Canton-
neighbourhood, which was largely 211) On May 2nd I met Mr W J
North-West Provinces
o Lucknow, I going on
engineer and resident Benares May 3—5
of the North West Provin waterworks, took charge of me, and we visited the
suggestion, I travelled to he Ganges, and on the following day the land
Mr King, the Executive F for the purpose of a sewage farm At Benares I
head works of the Gan e of Mr Adams, the Commissioner, Mr James
diverted into the canal. and Mr W Venis, analyst to the Municipality From
the side of the canal on May 5th, to Lucknow, where I met Dr Fuhrer, Lucknow, May 6
great works by mean know Museum, and Mr E Smith, of the Archæological
and lastly over, the
Rurki, and took t I
and thence into C Nai
the 20th I of Agr
Lucknow P with w Naini Tal May 7—10
Ridley afternoon of Ma
met a number of the officials of the North West Government, and had many
interesting interviews Among these I would mention one with His Honour
the Lieutenant Governor (Sir Auckland Colvin), and several with Mr T
W. Holderness (Director of the her,
Mr T H Wickes (chief engin and
Mr A J. Hughes In addition, W.
Woodburn (Chief Secretary to also
Mr. R Smeaton (Financial Secretary to Government), Mr C. J Connell
(Secretary, Board of Revenue), Colonel Thomason, Colonel Harrison
(chief engineer, Irrigation Branch, North West Provinces and Oudh), Dr
Richardson (Inspector General of Civil Hospitals), and Dr G Hutcheson
(Sanitary Commissioner) During my stay I was the guest of Mr W J
Wilson, whose experience in irrigation as well as in experimental work
on reclamation of salty land (*usar*), and on the establishment of "Fuel and
Fodder Reserves, was of great advantage to me Mr A Grant, supervising
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ployed Simla May 19
this interval in putting together the notes I had taken during my tour, in
reading Settlement and other Reports of the districts I had visited as well
as the principal Government papers upon subjects with which my inquiry
was more specially concerned I had also the opportunity of meeting a
number of the high officials of Government all of whom received me most
kindly and gave me much assistance His Excellency the Viceroy espe-
cially showed much interest in the matter of my inquiry, and gave me
renewed interviews The Members of Council, Sir David Barbour, Sir George
Chesney Sir Charles Elliott, the Hon Mr Hutchins and Sir James Lyall
also allowed me to discuss with them the views I had formed Among
other officials whom I met and by whose experience I benefited greatly,
were the
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helped me in every way he could Before leaving for my second tour, I drew up my general conclusions in the form of "Preliminary Notes," which were printed and circulated, and subsequently discussed at the Agricultural Conference in the following October

Second Tour 1890.

Second Tour, July 14th to Sept. 12th 1890.

Simla, July 14

Just after the rains had set in I started off again on my travels, and leaving Simla on July 14th in company with Dr Hendley, of Jeypore, made my way again to the plains Passing by way of Delhi, we arrived on

Jeypore, July 17—18.

Here I had an agricultural talk with e Jeypore State, Rai Bahadur Kamtee seeing, under Dr Hendley's guidance,

Ahmedabad, July 20—21

Nadiad, July 22

joined by Mr Kacherao Jadhava, a Native in the service of the Gaekwar of Baroda and formerly a student at Cirencester College We were met at Nadiad by Rai Bahadur Becherdas Viharidas Desai, a leading agriculturist, the Secretary of re in the town we went to the Mr Becherdas's tivation of the 40) and with features We also visited here a hospital (*Pinjrapol*) for disabled and dying cattle The same evening we left for Baroda, and stayed there with Mr F A H

Baroda, July 23

Sir Harry Prendergast, and Mr W. S. Price, superintendent of the In the evening we left, and travelled to Palghar, in the we drove to Mâhim Here we saw the splendid growing of sugar-cane, plantains, ginger, *betel-* ative crops (para 119), besides the system of seed- is *rāb* (para 137), for rice and millet (*nâgli*) met Mr Dhondo Vinayek Dandekar, a leading landed proprietor, Mr Padmaker Narayan, *Mamlatdar* of Mahim, and many others In the afternoon we drove back to Palghar, and thence by train to Bombay The next day I called on Mr John Marshall, of the Chamber of Commerce, and had a long talk with him on the subject of wheat-cleaning (para. 376 *et seq.*), and oil seed cleaning (para 378) and upon the trade in cotton (para. 338). From Messrs Croft Wells & Co I gathered information on the collection and export of bones (para 112), from Messrs Volkart Brothers on trade in cotton, bones, and manures, and from Messrs Glads & Co, on the manufacture and trade in oil-cakes (para 127). On the 26th inst. we went on to Poona, I leaving the others at Kirkee as I was to be His Excellency the Governor's (Lord Harris) guest at Ganesh Khind Mr Lee-Warner, Political Secretary to Government,

Bombay, July 25

Poona, July 26—29

was also staying at Ganesh Khind at the time With Mr. Ozanne I went over the Ganesh Khind Gardens (para 490), and on July 28th drove with him and Mr Middleton to Mundwa, a few miles out of Poona, to see the sugar-cane and other cultivation of the district which is carried on by canal irrigation and the use of night-soil (poudrette) (para. 149). We also went over a distillery where spirit is made from the fruit of the *Mahua* tree In the afternoon I met at the office of the Department of Land Records and Agriculture Mr Bhimbhai, the Assistant Director, and later on we held a conference with the principal landowners, agriculturists, and native officials of Poona Among those present, besides Mr Ozanne, Mr. Middleton, Mr Bhimbhai, and myself, were Rai Bahadur Mahdeo Govind Ranade (Judge under the Deccan Relief Act), Rai Bahadur Yeshwant Moreshwar Kelkar (Oriental Interpreter to the Government), Mr Dorabji [illegible]

[illegible]

Belgaum July 29–30

[illegible] Deputy Collector, the Hon Gahrshitapa Virbasapa, we heard of the success which had attended the efforts to popularise the system of Government Advances (*taccavi*) for agricultural purposes (para. 109) Next day we inspected the farm attached to the Agricultural Class of the High School (para 522), and then went to see the market gardening around the town At noon we left for Bellary, passing *en route* Dharwar, Gadag, and Hubli At Bellary, wh[illegible]

Mudliar m[illegible]
prickly pe[illegible]
on his est[illegible]
(para 143[illegible]
irrigation[illegible]
long here,[illegible]
Mr C H ([illegible]

[illegible]

Hampi Aug 1.

Bijapur, Aug. 2-3

Poona Aug 4.

Kalyan, Aug 5.

[illegible] Ghats into the Nasick district and alighted at Igatpuri Here we saw more rice and millet (*nágli*) cultivation, some of it by the seed bed system called *rab*, there being no irrigation, but simply very heavy rainfall. Buffaloes were here the plough cattle (para 260) In the evening we took the train again

and reached Pachora on the morning of 6th August going on thence to the Bhadgaon Farm which we reached after crossing four different rivers, these were then in flood, and presented considerable difficulty to our passage Arrived at the Farm we went carefully over it (para 483), seeing then the rainy season (*kharif*) crops, just as on my previous visit I had seen the cold weather (*rabi*) crops We also saw the herd of Mysore cattle (para 2.5), the formation of a *babul* (*Acacia arabica*) plantation (para 180), and the making of silage (para 226) The next day we left, and, after visiting a cotton cleaning (*ginning*) factory *en route*, at Pachora I parted company with Mr Ozanne and Mr Middleton Taking the train on to Nagpur, I arrived there on the morning of the 8th and went to Mr J B Fuller's, where I stayed this and the next two days At Nagpur I had an interview with Mr (now Sir Alexander) Mackenzie the Chief Commissioner, and among others I met and discussed agricultural matters with Mr J Neil (Judicial Commissioner), Mr A Munro (Director of Public Instruction), Colonel Van Someren and Mr P T Thompson (Conservators of Forests) and Colonel Scott Mr Fuller took me over the Nagpur Experimental Farm (para 480) the management of which is in the hands of Mr Mahaluxmivala After this, we inspected the Agricultural Class and museum (para 521), Mr Joshi, formerly a Poona student, being teacher of agriculture At other times we visited the plots of land cultivated by the students of the Agricultural Class, and also the land outside the town where the night soil and town refuse are utilised by the *Kâchhis* and other cultivators who have followed their example (para 149) On the evening of August 10th I left Nagpur for Calcutta At Allahabad I met Mr A J Hughes Supervising Municipal Engineer, North-West Provinces and travelled part of the way with him, hearing from him what had been done in furtherance of the sanitary schemes we had discussed before It was now the middle of the rainy season and a great part of the district passed through was covered with water Arriving at Calcutta on the morning of the 13th I spent the day with Mr Finucane, Director of Land Records and Agriculture, Bengal and in the evening set off with him and Mr P Nolan Revenue Secretary for a short tour in Eastern Bengal The train took us as far as Goalundo Dr Comins, Superintendent of Emigration, travelling with us At Goalundo we embarked on the steamer for Serajgunge, and during the sail up the Brahmapootra river we saw the numerous villages on the islands dotted about on the river or along its banks, together with their rice and jute cultivation (para 374) At Serajgunge, Mr Cuthbert Macdonell, manager of the Serajgunge Jute Mills, and his assistant Mr Ogbourne, met us and took us off in their steam launch to their house We stayed here until the 17th, and met Mr Andrew Hannah, Mr S Gowan, and other jute commission-agents On the 15th instant we took a long trip of about 30 miles in the steam launch to Solanga going up the streams then intersecting the country and noting the jute and rice growing everywhere along the banks On the 16th we saw over the Serajgunge Jute Mills, and in the afternoon Mr Finucane and I went about in a boat and called at several of the islands for the purpose of seeing how the cultivation was carried on as well as the preparation of the jute and its packing for market On the 17th we left Serajgunge, and returned to Calcutta on the 18th The same afternoon I went with Mr Finucane to inspect the Seebpore Experimental Farm (para 493) and met here Mr Basu and Mr Banerji of the Bengal Agricultural Department The day following I had an interview with Mr R Blechynden, Secretary of the Agricultural and Horticultural Society of India, in relation to the coming of a chemist to India to enquire into problems connected with the cultivation and manufacture of tea (para 361). In the evening Mr Nolan Mr Finucane, and I left for Dumraon, where we were to meet His Honour the Lieutenant Governor of Bengal, Sir Steuart Bayley then on tour This we did, and with His Honour went round to see the school, hospital, museum, and other places, subsequently meeting again at a dinner given in the Lieutenant-Governor's honour Among the party were Mr C C. Stevens Officiating Chief Secretary to Government Mr. W Kemble, Opium Agent Bankipur, Mr J Charles, Judge of Shahabad, and Mr J Bernard Officiating Collector, Shahabad On the 21st we went over the Dumraon Experimental Farm with Mr Basu (para 492), and subsequently had an interview with the Maharajah of Dumraon and Rai

Margin notes: Bhadgaon, Aug 6—7; Nagpur Aug 8—10; Calcutta, Aug 13; Serajgunge Aug 13—17; Calcutta Aug 18—19; Dumraon Aug 20 21

Bahadur Jai Prakash Lal the manager of the Dumraon Estate (*Raj*) In the afternoon Mr Finucane and I left Mr Nolan and the others and crossed the Ganges at Mokameh, proceeding into Tirhoot for a short tour there in order to see the manufacture of indigo (para 319) We first went to Bara, and drove to Mr W. B Hudson's at Seeraha, where we arrived on the morning of August 22nd I was just in time to see the cutting and steeping of the indigo plant, and the subsequent preparation of the dye in its different stages Leaving Seeraha on the 23rd we went on to Motihari, and stayed with Mr W D Blyth, the Collector Here I met again Mr. Apperley and Mr Seeley On the morning following we went with Mr Blyth by train to Bettiah and were the guests of Mr T M Gibbon, manager of the Bettiah Estates The country here was much flooded, but we saw the cultivation as far as we could and I had much interesting conversation with Mr Gibbon The following morning we left again, and at Motihari I ended my tour with Mr. Finucane, and proceeded alone to Allahabad, which I reached on August 26th. Here I visited Mr S A Hill and Captain F C Chapman, and went over the Allahabad Grass Farm again with Captain Hallowes and Sergeant Meagher (para 216). A large quantity of silage was being made at the time (para 221) I took the night train to Cawnpore, and, arriving there on the 27th I drove to the Experimental Farm and made another inspection of it with Mr Lachman Parshad, the personal assistant to the Director After calling on Mr Wishart I left again for Hissar, where on the 28th inst I was to meet Mr E. A. Robertson, Director of Land Records and Agriculture, Punjab, and to make, under his guidance, a short tour in the Punjab I duly arrived at Hissar and met Mr Robertson, we both staying with Captain Marrett, Superintendent of the Hissar Cattle Farm On the morning of the 29th Captain Marrett drove us over the Grass Farm for some 10 miles to Khairwan, where we saw the different herds of cattle kept on the farm (*see* para 254) On our return we found Colonel Patch (Commissary General, Northern Circle, Bengal) and Captain (now Major) Wingate (Special Forage Officer), and had a conversation upon the system of Grass Farms (para 215) We then went over the Home Farm, and saw the young stock, as also the growing of Lucerne and other green crops (para 236), and the making of silage (paras 224, 226) Next day we met Mr A Anderson (Deputy Commissioner) and went with him to see the cultivation of the neighbourhood, both on canal irrigated and on unirrigated ("dry") land Later on we visited the sheep and goat-breeding Farm (para 270), and left in the evening for Ferozepore, arriving there early on August 31st Mr E B Francis (Deputy Commissioner) took charge of us, and drove us round to see the cultivation near the town, as well as the system of inundation canals (para 92) On September 1st we drove out towards Ludhiana, and saw several villages where the cultivation was mainly carried on by men of the Jat caste In the afternoon we left for Changa Manga and put up at the Forest bungalow Mr A. V Munro, Assistant Conservator, and Mr Fazil Din, Sub assistant Conservator, took us over the "reserves (paras 177, 221) and grass runs (*rukhs*), as also to the more distant *rukh* Jelleke

Seeraha, Aug 22—23.
Motihari, Aug 23
Bettiah, Aug 24
Allahabad, Aug 26
Cawnpore, Aug 27
Hissar Aug 29—30
Ferozepore Aug 31—Sept 1
Changa Manga Sept 2

In the evening we took the train to Multan, and got there early on September 3rd, going to the Deputy Commissioner's, Mr H C. Cookson Mr Cookson drove me round the town, showing me the cultivation and the inundation canals (r[illegible] parts, where, among other thing[illegible]cording to the native method O[illegible]ith (Executive Engineer, Sidhnai [illegible] and then rode out to see the systen[illegible] villages which had been established along the Sidhnai Canal since the latter had been brought to the district (para 86) Previous to this only a small part of the area had been under cultivation On the morning of September 5th Mr Cookson and Mr Smith returned to Multan, and I continued my journey with Mr Robertson to Lahore, Montgomery being passed on the way On the 6th inst Mr A V Munro met us again, and took us over the Shahdara plantation (para 177), a little outside Lahore After this

Multan Sept 3
Rashida Sept 4
Lahore Sep 6

we went to the veterinary school, dispensary, and hospital, and saw the stallions of the Horse-breeding Department which are kept here (para 269) Starting off again in the evening by train, Mr Robertson and I reached
Gujrát (Punjab) Sept 7. Gujrát (Punjab), and were met by Mr E B Steedman, Deputy Commissioner, and formerly Director of Agriculture, Punjab, and by Captain Davies, Settlement Collector. The following morning we rode out and saw the crops, here mostly irrigated from wells We passed also large tracts of land flooded with silt from the mountain streams and channels, and which form the rich wheat growing stretches of these parts (para 13°) Splendid cattle, which came originally from Hissar, were seen here (para. 254), and there was also a Depôt of the Horse breeding Department (para
Mian Mir, Sept. 8. 269) We left Gujrát at night, and arrived next morning at Mian Mir, where we halted to *see one of the military Grass Farms The one we* visited was *rukh* Terah, and the grass was then being cut, and a great deal was being packed into silos dug in the ground (para 229). From here we
Amritsar Sept. 8–9 went on to Amritsar, and became the guests of Mr J. A. Grant, Deputy Commissioner Mr. Grant took us in the afternoon to see the town, its temples, etc, and *also the system of town sanitation so successfully adopted* here (para 149). On September 9th we were out early, and spent a long morning in seeing the extensive market-garden cultivation carried on all around Amritsar by the help of irrigation from the canal (Bari-Doab Canal) and the night-soil and sweepings from the town (para 149). *Vegetables were being raised in great profusion, also sugar cane and* maize We passed on to a village, Sultanwind, on the other side *of* the canal where canal irrigation is only *partial*, and *wells* are *dug* for supplementing it Returning to Amritsar, we made a closer inspection of the sanitation system (para 149), and went to other land on which the sullage water is pumped Later in the day I met Mr E Nicholl, the Secretary to the Municipal Committee, and he explained to me in detail what had been done *In the evening we left for Kirtapoor, where Dr*
Kapurthala, Sept. 10 Warburton met us and drove us out to Kapurthala. Here we were met by Major Massy, the Superintendent of the Kapurthala State We received a visit next morning from the Rajah of Kapurthala, which we returned in the afternoon Meean Aziz Bukhush, the Collector of the *State, also came* and had an *agricultural conversation with me I have to* acknowledge much valuable information and many useful suggestions given to me by Major Massy during our stay *Later on* we drove out to see the cultivation and the plantations that had been started round the town
Hoshiarpur Sept 11 On the morning of September 11th we left Kapurthala, and drove, *viâ* Jullundur, to Hoshiarpur, a distance of 36 miles The road took us past excellent cultivation, and we made several halts on the way to see this or that *object of special interest* Cultivation by *well irrigation* was a marked feature, and we saw a great deal of digging of wells going on, the wells in places, being quite near the surface *Sugar-cane* was *extensively grown* We passed some wide sandy tracts known as the "choh lands"(para 71), where no cultivation exists, but the soil is covered with transported, or "blown" sand Arrived at Hoshiarpur, Mr. Robertson had the village *records and maps of the village accountants (patwaris)* brought for my inspection, *later on we drove out to see* the cultivation around the town Sugar-cane was the principal crop growing, and large quantities of manure are used for it, the night soil and town refuse being assiduously saved (para 149) Cactus hedges encircle the fields, and firewood is fairly abundant An Arab stallion belonging to the Horse-breeding Department is kept here (para. 269) *After calling* on Colonel Wood, the Deputy
Umballa, Sept 12 Commissioner, we left Hoshiarpur and drove back the 25 miles to Jullundur, from which we took the train to *Umballa, where we arrived on* the morning of September 12th We halted a short time to see the cotton crops which grow here on unirrigated land (wells being hard to dig) and
Simla Sept 12 then drove to Kalka, finally concluding my second tour by reaching Simla on the evening of September 12th

I now had to settle down to prepare for (1) the Agricultural Conference, which was *to meet at Simla on October 6th and following days*, (2) the compilation of my Report. My work was, however, delayed for a time by

an attack of malarial fever, contracted, doubtless, during my Punjab tour with Mr Robertson, for Mr Robertson was laid up at the same time and unfortunately was ill for some time afterwards My attack lasted but a short time, and on getting well enough, Dr Watt took me with him for a very enjoyable three days' trip to the Suni Valley, and the basin of the Sutlej river On my return I found myself once again among the officials whom I had met in the previous May and June, and who had given me so much help In addition I met Mr R S. Whitall, Mr. McIntyre, and Mr. J H. Lace, all of the Forest Department

Mr J. B Fuller (Commissioner of Settlements and Agriculture, Central Provinces), arrived in Simla on September 29th, previous to the sittings of the Agricultural Conference, and on October 4th Sir Edward Buck returned from furlough, and resumed the duties of his office Mr Clogstoun, Mr. Nolan, Mr. Ozanne Mr Finucane, Dr Theodore Cooke, and Mr Middleton, and other members of the Agricultural Conference arrived subsequently, and the first meeting was held on the afternoon of 6th October There were seven sittings in all, and the Conference broke up on October 13th, after giving a general approval to the proposals which in the form of "Preliminary [illegible]

Agricultural Conference, Simla, Oct. 4–13.

[illegible]

off the first twelve chapters, in such a form that I was able, before leaving India, to send them to different people for perusal In the correction of these proofs Sir Edward Buck Mr J B Fuller Mr J E O Conor, Mr Ozanne, Mr Finucane, and Mr H C Hill, gave me most valuable help

Third Tour, November 3rd 1890 to January 10th 1891.

Third Tour

I left Simla on Novembe [illegible] the train for Ajmere, where I had [illegible] to see the Ajmere Merwara forests [illegible] rly on the morning of November 25th, and later on set off with Mr Hill to the Nagpahr forests, where we saw the "reserves" that had been made on the hill sides around Ajmere We then came down the hill again, and went first to Pokhar, where nurseries are formed, and then to Pushkar where a Fair was being held, and at which there were a great number of horses, many of them very good. In the afternoon Mr Hill and I went to the *Mohwa bir* (para 181), another "reserve on the other side of Ajmere We made an early start next morning, took the train to Biawar, and rode until we came to the "Chang reserve,' which is principally used for supplying firewood, small timber, and grass, as well as for grazing in time of drought This we went carefully through (para 181) Sirdar Hira Singh, the Sub assistant Conservator, was present to point everything out to us, and we ended up at Sendra From this place I proceeded next morning alone, but met Sir Edward [illegible] the train [illegible] and Dr [illegible] Theodore [illegible] quaintan [illegible]

Simla, Nov 23. Ajmere Nov 25. Ajmere reserves, Nov 26.

[illegible] and Mr [illegible] Bombay. [illegible]

Bombay Nov [illegible] Poona Nov [illegible] Dec 3

Extract from the Proceedings of the Government of India in the Department of Revenue and Agriculture,—No 3—37 21, dated Calcutta, the 20th March 1897.

READ—

Part I, Famine Commissioners' Report.

Despatch No. 19, dated 14th March 1881, to Secretary of State.

Despatch No. 55, dated 16th June 1881, from Secretary of State.

Government of India, Resolution No. 6—310-50-G, dated 8th December 1881.

Despatch No 151, dated 26th May 1882, to Secretary of State.

Despatch No. 197, dated 21st July 1888, to Secretary of State

Despatch No 104, dated 13th December 1888, from Secretary of State.

Despatch No. 6, dated 1st June 1889, to Secretary of State.

Despatch No 108, dated 7th November 1889, from Secretary of State.

Government of India, Resolution No. 545—55 C I., dated 25th March 1890.

Government of India, Resolution No. 24—21-17, dated 22nd June 1893

Government of India, Resolution No. 2—13-1, dated 31st January 1894.

Government of India, Resolution No 15—93-1, dated 7th September 1895.

Government of India, Resolution No 17—95-1, dated 17th September 1895

Government of India, Resolution No 19—98-1, dated 20th September 1895.

Government of India, Resolution No. 20—353-1, dated 2nd October 1895

READ ALSO—

Dr. Voelcker's Report on Indian Agriculture, 1893.

Calcutta Survey Conference Proceedings of 1882.

Calcutta Statistical Conference Proceedings of 1883.

Delhi Agricultural		,,	,,	,, 1888.
Simla	,,	,,	,,	,, 1890.
,,	,,	,,	,,	,, 1893.

Letters from the Chief Commissioner, Burma, Nos. 123—S—3, dated 6th December 1895, 784—11-A—1, dated 27th March 1896, and 86—8-A—3, dated 3rd July 1896.

Letter from the Secretary for Berar to the Resident, Hyderabad, No. 124, dated 13th May 1896.

Letters from the Chief Commissioner, Assam, Nos. 62-A.—2016-R. and 276-A.—2019 R, dated 30th May 1896, and No. 185-A.—2099-R., dated 4th June 1896.

Letters from the Government of Bombay, Nos. 4587, dated 10th June 1896, and 1337, dated 15th July 1896.

Letter from the Government of the North-Western Provinces and Oudh, No. 2012, dated 10th June 1896.

Letter from the Government of the Punjab, No. 193-S, dated 17th June 1896.

Letter from the Government of Bengal, No. 630-T.-R., dated 24th June 1896.

Letter from the Chief Commissioner, Central Provinces, No. 2416, dated 7th July 1896.

Letters from the Government of Madras, Nos. 488 and 491, dated 24th September 1896.

Resolutions on the Proceedings of the Agricultural Conferences of 1893 and of 1895-96

FIRST RESOLUTION

PREFATORY

In October 1893 a conference was held at Simla attended by delegates from all provinces for the purpose of discussing the [illegible]

The report of the Conference of 1893 was circulated to all local Governments and administrations for preliminary consideration with Resolution No. 2, dated 31st January 1894.

In a subsequent Resolution No 15, dated 7th September 1895, each provincial government was invited to arrange for a local conference which should discuss the question how far the proposals and recomendations embodied in the report of 1893 could be adapted to the circumstances of the province addressed The proceedings of all conferences together with the views of all local governments and administrations thereon, are now before the Government of India who, as intimated in 1894, will deal with the subjects concerned in a series of separate Resolutions

The present or *first* Resolution will be confined to an historical summary of the circumstances which have led up to the present position, and to a brief statement of the subjects which will be dealt with in the Resolutions to which it is a preface.

2. The policy of creating special departments to investigate the conditions of agriculture in India with a view to agricultural improvement was first brought forward in 1866 by the Commission appointed to deal with the Orissa famine, and the subject was brought under very full consideration by Lord Mayo's Government in 1870 The result of the deliberations then held was an important scheme for the constitution of both imperial and provincial departments of agriculture It was represented to Her Majesty's Secretary of State that while a central department was necessary for co ordinating the programme of enquiry and the results of investigation, yet that the "real work of studying and improving agriculture must rest with provincial departments" It was proposed, therefore, that a department should be created in every province under the control of an official director In accordance, however, with the Secretary of State's instructions the step first taken was the formation in 1871 of a new branch of the imperial secretariat which was to deal with the development of the general scheme. This measure was followed in 1875 by the establishment of a provincial department of agriculture in the North Western Provinces by Sir John Strachey who had as a member of Lord

Mayo's Government taken a leading part in the original programme. Further development was checked by the financial difficulties which were due to the famine and scarcity prevailing in 1876, 1877 and 1878, and which not only prevented new action in the provinces, but led to the temporary suppression of the imperial department in 1879 It is interesting, however, to note that the very famine which thus arrested progress brought about the resuscitation of Lord Mayo's scheme on a wider and firmer basis by attracting renewed attention to the importance of improving Indian agriculture The original scheme had been initiated by the Commission which dealt with the Orissa Famine The revised scheme was put forward ten years later by the 'Famine Commission' which investigated the causes and phenomena of famine in all parts of India. The fact that the creation of agricultural departments has thus been twice due to the deliberate and unprejudiced conclusions formed by special Commissions appointed to advise the Government on the action which should be taken to cope with famine and scarcity, brings into prominent importance at the present time, when the empire is again suffering from a widespread failure of the harvests, all questions relating to the development of the scheme for agricultural improvement

3 The Famine Commission was sent out in 1878 to this country at the instance of Parliament with a mission to enquire 'how far it is possible for Government, by its action, to diminish the severity of famines or to place the people in a better condition for enduring them " The Commissioners after a prolonged tour through India submitted their report in 1880 They gave prominent consideration to the desirability of extending railways and communications, of enlarging the canal system, and of otherwise expanding the large protective works of the country They also suggested the measures which should be taken on the actual occurrence of scarcity or famine But the greater part of their report was occupied with recommendations for the reform of land administration and for the promotion of agricultural improvement They considered that agricultural prosperity in ordinary times was the best shield against the difficulties and trials of a season of drought, and insisted on the necessity of taking every measure which might, on the one hand, prevent or minimize agricultural loss and distress or, on the other hand, tend to increase and improve the produce of agricultural land They advised that for dealing with these matters imperial and provincial departments of agriculture should be established.

4 In pursuance of the Famine Commissioners' advice an imperial department was created in 1881, which at once, under the instructions of Her Majesty's Secretary of State, took measures to arrange with the local Governments for the organization of provincial departments In an opening Resolution of 1881, the duties of the new departments were summed up by the Government of India following the Secretary of State, as agricultural enquiry, agricultural improvement, and famine relief The third of these duties, which is concerned with the conduct of operations

in the actual event of scarcity, has been dealt with in the famine codes drawn up in 1882 and revised in recent years, and forms no part of the discussions now under review Present considerations are confined to the measures which should be taken to secure an effective scheme of agricultural enquiry, *i e*, the collection of agricultural information, facts and statistics, and to open the way to improvements in agricultural methods and practices

5 No pains were spared by the imperial and provincial Governments to subject the recommendations of the Famine Commissioners to the most intelligent criticism that could be brought to bear upon them Every scheme or measure of importance that was from time to time proposed or suggested was placed before a conference at which every province concerned was represented by selected officials and experts connected with the administration of land or with the conduct of the agricultural departments Thus, in 1882, a *first* conference was convened at Calcutta at which the principles were determined on which future cadastral surveys which are the basis of agricultural statistics should be conducted A *second* general conference, held at Calcutta in 1883, prepared a scheme for the registration of inland trade statistics, and for the compilation and publication of agricultural and trade returns A *third* at Delhi in 1888 dealt with the important subject of agricultural education

6 In 1889, correspondence with Her Majesty's Secretary of State led to an important event in the history of the agricultural programme, *viz*, the deputation to India of a second Commission from home in the person of Dr. Voelcker, consulting chemist to the Royal Agricultural Society, whose mission was ' to advise on the best course to be adopted in order to apply the teachings of agricultural chemistry, and in order to effect improvements in Indian agriculture ' Every branch of agricultural enquiry and reform was thus to be open to his examination Dr Voelcker, following the example of the Famine Commissioners, made a tour through India and gained a general knowledge of the directions in which agricultural enquiry and improvement might be developed His report may be viewed as an amplification in detail of the recommendations of the Famine Commissioners with which in all important matters his views were in general accord

In every province be had the opportunity of consulting the local authorities, and before writing his report had the advantage of meeting, at Simla, a *fourth* general conference of delegates and experts from all provinces who went over with him the whole ground of the Famine Commissioners' recommendations so far as they applied to agricultural enquiry and improvement His report when received two years later was submitted in Simla in 1893, to the consideration of a *fifth* general conference, whose recommendations have now been separately discussed by a committee of selected officers at the head-quarters of each province

7 The Governor General in Council is not disposed to regret the time which has been occupied by continuous deliberation The scheme of 1880 was so vast in its design, so important in its

objects, so wide in its scope as to demand that the utmost care and caution should be bestowed on its full development Material progress has indeed been made The earlier years of the past decade were occupied in laying the foundations of agricultural enquiry by the organization of land record establishments, in inaugurating investigation in many important directions, and in developing plans of agricultural experiment Each successive conference led to further advance and to new measures But the general principles and policy by which the whole scheme of agricultural enquiry and improvement were to be governed had not been finally or precisely formulated The very complete examination of the issues left for decision, which has now been made by provincial authorities and local Governments, places the Government of India for the first time in a position to amplify, with further approach to precision, the instructions of the Resolution of 1881, in which the duties of imperial and agricultural departments were necessarily sketched only in broad and rough outline It must be understood, however, that progress has only advanced to one more stage Every step that is taken in future years will lead to further knowledge of facts and conditions, and will open up new issues The time may soon come when the combined advice and counsel of provincial authorities and of the experts by whom they are aided, will again be required for placing provincial and imperial governments in a position to decide what further measures are necessary to secure safe progress

8 The despatch in which the duties of agricultural departments were formulated by the Secretary of State indicated the desirability of postponing any general consideration of the possibilities of agricultural improvement until a proper system of agricultural enquiry had been set on foot The Government of India adopted this view They pointed out, however, that an investigating agency must be established before enquiry could begin. The Resolution of 1881 indicated that the first measure must be the organization of machinery for the continuous collection of facts and statistics concerning the agriculture of the country Ten years previously Lord Mayo had insisted that the "splendid local machinery of which we are in possession in our local establishments closely connected with the operations of agriculture, should be utilized in the collection and production of those agricultural statistics which are so essential to the development of agricultural progress" The same opinion was held by the Famine Commissioners, and was accepted by both the Secretary of State and the Government of India

The measures taken to introduce or improve land-records establishments, will form the subject of the second Resolution, the system adopted to utilise their services and the agricultural statistics supplied by them will be dealt with in the third Resolution

9 But the scheme of agricultural enquiry, as set forth by the Famine Commissioners and by the Secretary of State in 1880 and 1881, involved the investigation of wider fields than that occupied

by the facts and statistics of the land records These latter, it is true, supply continuous information regarding crops, irrigation, the occupancy and cultivation of land, and other circumstances connected with agriculture, without which no sound conclusions can be formed as to the general condition and needs of each agricultural tract. But, as pointed out by the Famine Commissioners, and [illegible] be extended to all [illegible] The character of soil [illegible] of cattle, the diseases of plants—their causes and the means by which they can be prevented, minimized or cured; the extension of irrigation; the effect and value of canal water; the improvement of fuel and fodder supplies; the reclamation [illegible]; meteorological [illegible] old, and intro- [illegible] ments; possible [illegible] all such sub- [illegible] the programme of enquiry.

10. It was evident that in exploring the fields of investigation thus briefly sketched, the agricultural departments, imperial and provincial, must, as the Famine Commissioners had indicated, be assisted by competent experts Some of the ground indeed had already been occupied by scientific investigators thus for many years geological officers had [illegible] and strata of each province, [illegible] arranged the flora of forests [illegible] ment had [illegible] climates [illegible] measures [illegible] and improve agricultural conditions But it was obvious that much more was necessary for the completion of [illegible] equally clear that the [illegible] sion must be, for some [illegible] and provincial authorities In other words, that there must be an imperial as well as a provincial scheme of scientific enquiry. In many directions the work of investigation was national rather than local in character. It demanded the services of first class experts, such as each province could not afford and did not indeed separately require The existing departments of geology and meteorology were cases in point. Scientific research in such fields could not be restricted to geographical or administrative limits, and would, if confined within narrower limits than those of the empire, involve waste of power and unnecessary expenditure Influenced by these views, the Government of India accepted the responsibility of widening, under imperial direction, the scheme of national investigation, hitherto covering only a limited portion of the ground which had to be occupied Thus, economic products, cattle diseases, agricultural entomology, were some of the subjects which were between 1880 and 1890 brought for the first time under systematic enquiry by experts attached to the imperial department.

The general character of the national scheme of scientific

SECOND RESOLUTION.

LAND RECORD ESTABLISHMENTS

The foundation of all land administration is the field. More especially must agricultural inquiry and reform, which are now recognised as an integral part of land administration, be based upon the facts and figures recorded in connection with each individual field of an Indian village. To quote the words presented to Her Majesty's Secretary of State twenty years ago—

India is an agricultural country composed of a multiplicity of minute holdings and almost every subject which we take in hand in connection with the administration of the country must be referred to the units of which it is formed. A measure which makes a very slight alteration in the condition of each unit may have a very important effect on the whole country, since what may be termed the atomic changes are combined by enormous multiples. It may seem a little thing to ensure the correct record of facts connected with a single field but when we consider that the country is nothing but a congeries of single fields the subject assumes an importance which is apt to be lost sight of in discussing the manipulation of a village register.

The first requisite in any programme for agricultural inquiry and improvement is, therefore, the efficiency of the land-record establishments.

2. To each village or group of villages in this country there had always been attached a village accountant. His hereditary duties are to provide annually for each field a correct record of area, occupancy, rent, crops and of other facts and statistics called for by his official superiors. In some parts of India a hereditary claim to the office has been scrupulously maintained. In others the hereditary right has been greatly weakened or entirely abandoned. But whatever may be the position of the hereditary claim, the literary duties of the office have still to be performed, and since the conduct of land administration and agricultural reform depend largely on the records of the village officer it becomes a primary duty of the authorities to take such measures as may be necessary to secure his efficiency.

3. As soon as the subject came under the special consideration of the Government of India, it was found that in many provinces the hereditary claim to the office had been allowed to override more or less the claim of the State to the efficiency of the holder of it, that the village officer was often so incompetent as to require an assistant for the performance of his work, that the land records had become incomplete and untrustworthy, that in some districts attempts to maintain anything like a correct record had ceased; that in others the office itself had been allowed to die out.

It had been proved, on the other hand, by results already obtained in more than one province that the village registers could be made to yield that punctual information of the circumstances of every agricultural tract which the Famine Commissioners had urged to be necessary for timely provision against scarcity, that the accountants could be trained to correct their maps from year to year in accordance with facts upon the ground, that their records, when carefully maintained, tended to facilitate the work of civil [illegible]

many direct economies should be effected by improving the village staff; that in some of the temporarily assessed provinces a correct record would mean a material reduction in the cost of periodic settlements; that, by a proper use of the village agency, expenditure on field surveys alone might be reduced from something like Rs. 200 to Rs. 60 a square mile; and that a series of annual statistics extending over a long period would afford a safer and broader basis for land assessment than the facts and figures hastily collected in a single year at great cost by huge temporary establishments.

4. When, therefore, in pursuance of the Famine Commissioners' recommendations new departments were, under the orders of Her Majesty's Secretary of State, created in each province for the purpose of dealing with agricultural facts and statistics, as a foundation for agricultural improvement, the Government of India desired that they should be made specially responsible to the local Governments and administrations for the restoration and improvement of the land record, and for the competence and efficiency of the officials by whom it was to be maintained. This, indeed, was to be their first duty The Famine Commission held the belief, to which expression had been given by Lord Mayo's Government ten years earlier, that agricultural science applied to Indian soils could materially increase the produce of the land and would thus go far to minimize the sufferings of the people in a season of scarcity, and it was in this view that they demanded the employment of agricultural experts and the creation of agricultural departments. But it was foreseen by the Government of India that attempts at agricultural development would require many years of continuous and patient investigation by experts before they could be expected to yield important or safe results, that in many cases they must be based on facts and figures which could only be derived from a long series of correct maps and records, and that everywhere the introduction of improvements into the agricultural system would require the instructed intelligence and co-operation of a class whose education had hardly yet begun. In the opening Resolution, therefore, of 1881, which prescribed the duties of the new departments, it [illegible]
must be [illegible]
meant tha[illegible]
and records, upon which enquiry was to be based, must be the first stage in schemes of agricultural reform.

SECOND RESOLUTION

Land Record Establishments

The foundation of all land administration is the field. More specially must agricultural inquiry and reform, which are now recognized as an integral part of land administration, be based upon the facts and figures recorded in connection with each individual field of an Indian village. To quote the words presented to Her Majesty's Secretary of State twenty years ago—

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The first requisite in any programme for agricultural inquiry and improvement is, therefore, the efficiency of the land record establishments.

2. To each village or group of villages in this country there had always been attached a village accountant. His hereditary duties are to provide annually for each field a correct record of area, occupancy, rent, crops and of other facts and statistics called for by his official superiors. In some parts of India a hereditary claim to the office has been scrupulously maintained. In others the hereditary right has been greatly weakened or entirely abandoned. But whatever may be the position of the hereditary claim, the hereditary duties of the office have still to be performed, and since the conduct of land administration and agricultural reform depend largely on the records of the village officer it becomes a primary duty of the authorities to take such measures as may be necessary to secure his efficiency.

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maintained, go far to minimize the employment of the village officer on annual or periodical revisions of survey.

Influenced by such considerations as these, as well as by the fact that in almost every province the utilization of village establishments had been found remunerative, the Governor General in Council did not impose any further condition on the maintenance of departments of land records and agriculture than to require, with the concurrence of Her Majesty's Secretary of State, that the maximum use shall be made of the village officer under all circumstances in which his employment can lead to further economy. In this view the claim of the State to his efficiency must be held to be paramount over all other claims

7. In dealing with the question the following circumstances must be borne in mind. The class to whom, by custom or by right of descent, the office belongs is intelligent and quick to learn; the status of the hereditary appointment, however poorly paid, is, where the right is strictly maintained, so far an object of ambition to the members of the family to which it is attached, as to justify a condition that they should, after a sufficient term of grace, qualify themselves for it; that cheap educational institutions provided at public expense are available to all who are likely to be candidates for the office, that, according to the evidence adduced [illegible] schools can, at no great [illegible] hose special branches of [illegible] educational curriculum. It may, therefore, safely be laid down that after a given date no village officer should be admitted to an appointment, who cannot satisfy the educational test required.

The test imposed must, in the opinion of the Government of [illegible] etent to enter new fields [illegible]. But whether or not he [illegible] in actual field survey, he [illegible] on the field

The Government of India would have some hesitation in enforcing this obligation if it entailed any real difficulty But the evidence adduced at the recent conferences and the quick results obtained even in provinces and native states where the education of village officers had for many years been neglected have proved that any school lad of the class from which village accountants are drawn can, as a rule, be taught in a few weeks all that is necessary for the field survey, under proper supervision, of any part of a village.

[illegible] ences indicate that the efficiency [illegible] ghest level in the Punjab, and [illegible] In that province the organization of village establishments had been taken in hand before the

creation of the new departments of land records, the hereditary claim, though not disregarded, was made strictly subservient to efficiency, close supervision was exercised over the village officials; the salary of the office was gradually raised; and considerable encouragement was given to those who held it by ensuring the promotion of the best men to supervisorships and other higher appointments. The rules lay down that at least two-thirds of the supervisors should be taken from the ranks of the village officers.

The Government of India are not prepared to advocate that the Punjab rules should be taken as a precise model for other provinces, but they commend the principles underlying them as sound. They think that the time should come when in every province a fair educational test including competence to survey, should be strictly imposed; adequate pay for the office should be provided; and excellence of [illegible] appointments. [illegible] should be taken, [illegible] standard of the agricultural population has not reached a high level, that the status of the village officer is not so unduly raised as to give him too masterful a position in the village or group of villages under his charge, and that, on the other, the admission of village officers into the ranks of their supervisors should not be made so free as to endanger the high standard of excellence which the controlling staff is, for reasons hereinafter given, expected to attain.

9. The history of the supervisor is very similar to that of the village officer. As in each village there was, under native rule, an accountant, so to each of the administrative circles, containing perhaps one or two hundred villages into which a district was divided, there was attached an official whose main duty it was to collate the returns received from village accountants, and to obtain such information of the agricultural and financial condition of the circle as [illegible] assigned to him were quite outside the traditional functions of his office.

10. When the reform of the land record system was taken in hand, the first step in almost every province was to restore the hereditary duties and functions of the circle officer. In some parts of India, where the hereditary responsibilities had been forgotten, the hereditary right to the office had been nevertheless even more strongly maintained than that of the village officer, and much care had to be taken to prevent it from being unduly interfered with by the initiation of the land record reforms. In such cases older men [illegible] to appoint substitutes or educated relatives, [illegible] was bound [illegible] to learn how to perform efficiently the real [illegible] of the latter who were hopelessly

incapable were ejected. At the same time it was found that a material expansion of the staff had become necessary. The extension of cultivated area, the growth of population, the demand for more elaborate statistics, all these and similar causes had doubled the work which had to be done. The number of circle officers that had sufficed for the needs of the earlier years of the century was wholly inadequate now. In almost every province, therefore, the staff was largely increased by the incorporation in it of the best of the men who had been for some years engaged in supervising the subordinate establishments of survey and settlement parties in the field. These recruits brought into the ranks of the effete service the very experience which was wanting. They were active men, accustomed to direct and control, and experts in the construction of field maps and field records Their example proved of great value to the hereditary staff.

The duties, partly peripatetic and partly sedentary, of the office, had, so far as they had been performed, been hitherto amalgamated. They were now divided. The circles were increased in number, and the areas correspondingly contracted. To each circle was attached a "peripatetic" officer for inspecting and controlling the work of 40 or 50 village officers. At the head quarters of each of the administrative sub-divisions of a district, perhaps from 5 to 10 in number, and each comprising 2 or 3 peripatetic circles, was located the "sedentary" official. The younger and more active of the staff were placed in charge of the smaller peripatetic circles. The older men were assigned to the sedentary office. The main duties of the peripatetic circle officers were to instruct the village officers; to examine their work, to note and report defects, to relieve as far as possible the higher officials from the necessity of personally inspecting the village officer's maps and records, to provide for his circle quick and early information of any kind that might be urgently called for in connection with the land or the people upon [illegible] of the [illegible] xecutive [illegible] The main [illegible] various returns sent in from the villages and to compile them in abstract forms for his group of circles At the head-quarters of the district a head supervisor was established, who was to make a similar compilation for the [illegible] of the whole st[illegible] anted officers [illegible] no longer to include the detailed inspection of the village officers' maps and records, but were to be confined to such an examination of the supervisor's work as would prove whether or not their duties of inspection and control were being properly performed, and to the adoption of such measures, punitive or otherwise, as might tend to improve their efficiency.

Such was the general character of the scheme of inspection and supervision which, with due regard to the varying conditions of each province, has been established in every part of India, except in those permanently-settled districts of Madras and Bengal in

[illegible] has not been [illegible] recent con- [illegible] the opportunity of ascertaining in what directions the improvement of the supervising machinery may in some provinces still be possible.

11 One important matter is the confinement of the supervising officers to their proper functions. They should not, on the one hand, be allowed to perform the [illegible] other, those which proper [illegible] staff [illegible] of t [illegible] to learn, has led [illegible] to the supervisi [illegible] procedure was pointed out by the Finance Commission In other cases the important duty of inspection has been interfered with by the practice of using the supervisors for enquiries and reports on matters unconnected with the village records This may, as in the Punjab, be checked by forbidding any order for reports and enquiries, other than for those prescribed by the rules, to be issued by sub-divisional or district officers. On either hand a transgression of the limits within which the duties of the office should be confined must be carefully prevented.

12 [illegible] the proper instr [illegible] Imperial Re- [illegible] the general principles on which the cadastral surveys of the country should be conducted and maintained [illegible] of utilizing the correctio [illegible] maps for the periodical [illegible] out. But unless confide [illegible] can be assured by profe [illegible] themselves are professionally connected with the survey stations laid down throughout India by th [illegible] cal departments, there may al [illegible] supplied by the provincial estab [illegible] the professional officers respons [illegible] and that the details already map [illegible] have to be mapped over again at great and unnecessary cost by the professional staff. Hitherto the survey operations which have [illegible] have not only supplied [illegible] trained in survey, for [illegible] the instruction of the [illegible] not be the case in future. Henceforward a practical knowledge of, and experience in, approved professional methods will, if precautions be not taken, gradually die out; and, as has already occurred in some cases, the field maps will become more and more inaccurate and unequal in quality. It is of importance that this result should not be allowed to occur, especially as, independently of the requirements of cartography, the maintenance of field maps up to a reasonably

* No 45 S., dated 4th September 1882.

fair standard is for all purposes of administration desirable. It is considered in some provinces that the best security against a gradual decline in the value of field maps, whenever these have been initially laid down on professional lines, is the periodical transfer of a limited number of survey officers of responsible position from the professional staff, whose duty it should be to preserve a knowledge of correct methods throughout all grades in the land record staff and to personally supervise or inspect all surveys which are of a materially more important character than the mere revision of a village map This policy has been accepted in Madras, in Bombay, and to some extent in the Central and North-West Provinces, while very full effect has been given to it in Burma, where the exceptionally shifting character of the cultivation has justified the employment in every district of a superior officer who is either transferred from the Survey Department or is thoroughly trained in survey The Governor General in Council now desires that the question may receive full and careful consideration in every province, in which no measures have yet been taken, for providing for the maintenance of maps on a correct professional basis and how far the central guidance of competent experts is likely to be useful

13 A third matter is the improvement of the supervising staff by securing for the best men in it a reasonable prospect of promotion to higher service The advantages of this course were pointed out in an imperial Resolution of 1883 It was then urged that promotion should not merely be permissible but obligatory, that it was not unnatural that vacancies in the regular line should usually be offered to those officials, or to their friends, who come most into personal contract with the officers in whose hands patronage rests, and that since the duties of circle officers usually confine them to outlying parts of the district, their claim to promotion in the regular line is apt to be overlooked unless a certain number of such appointments are strictly reserved for duly qualified members of the supervising staff

No 339, dated 14th March 1883

14. Very inadequate effect seems to have been given to this policy except in the Punjab, where its success has been marked No less than one third of the circle officers have been in the last *few years admitted to the higher revenue appointments, and now* no difficulty is found in attracting young men of good family and [illegible] rvisorships [illegible] time will [illegible] sought for by men who have obtained a graduate's degree at a University or a diploma at an Agricultural College.

A further advantage of the policy was indicated in the 1883 Resolution It was contended that, as the supervising officials acquire from the nature of their duties a considerable knowledge of agriculture and of the condition and circumstances of the agricultural classes, a free flow of promotion from their ranks would

infuse into the upper grades of the revenue service a useful acquaintance with the agricultural conditions of the district or province in which they hold office. The Government of India is pleased to observe from the proceedings now before them that this view has received strong support from both the conferences and the local Governments, and that the advantage of leavening the revenue service with officials who have learned their work in the field is fully recognized In the Punjab the value of the experience gained by a circle officer is so thoroughly appreciated that every candidate for a revenue appointment, whether a circle officer or not, is made to serve an apprenticeship, which may extend to two years, as a supervisor, and the plan is commended to the notice of all local Governments and administrations.

15 A difficulty is, in some provinces presented by the circumstance that the educational standard prescribed for entry into the upper grades of the revenue service is far higher than that which is or can for some time be, imposed for a circle supervisorship The difficulty is greatest in those provinces in which education has been most highly developed, in which universities are of the longest standing, and in which at the same time the inspecting staff has been allowed to fall into the worst condition of neglect and delay. While the revenue appointments have gradually become an object of ambition to university graduates, the hereditary officers have been filled by men from whom no educational test of any value has been required The one service has slowly advanced, the other slowly declined in quality, a gulf has been created between the two which it is not easy to bridge

In other provinces again, of which the Punjab may be taken as an example, the measures taken to improve the supervisor class were antecedent to the introduction of that high education which is represented by a university A long period of survey and settlement operations, conducted, as a rule, without the assistance of the professional survey department had created a large supervising staff in which existing circle officers were temporarily included, and from which it was easy to select for transfer to the permanent circle staff, intelligent and capable recruits with the very experience that was wanted for the management and control of village officers On the other hand, the educational standard for higher revenue posts was, as is still the case, low in comparison with that in provinces with universities of long standing The new men, with their practical experience, were found to be often better and more intelligent officers than many of those occupying higher positions in the regular establishments There has been no wide gulf to bridge, and the dovetailing of the two branches of the service has been, therefore, a simpler matter.

16. The Government of India while recognising the fact that the attainment of a policy of perfection must be a work of slow growth, conceive it to be necessary that a 'working plan' should be laid down for the gradual development of a sound system, and that the wide breach, where it exists, between the peripatetic service and the administrative service must be gradually narrowed

and eventually closed In provinces which have in recent years undergone survey operations, no wiser course can probably be followed than either to select for the peripatetic appointments the best of the survey supervisors who have gained a practical knowledge of field duties, or to train existing circle officers up to the same standard But a date should be named after which mere field experience and an acquaintance with the village land records should not, without much higher qualifications than these, admit a candidate to a circle appointment.

17. Taking a broad view of the subject, the Government of India have, upon a review of the conference proceedings and the letters with which they are forwarded, arrived at the following conclusions They deem that a serious obligation rests upon the State to utilize to the utmost extent for the benefit of the public service the educational system established in the country, that the time must come, as indeed in some parts of India it has come, when all officials required for the conduct of business connected with the land, excepting only those whose duties are of entirely a subordinate character, must attain the educational standard represented by a graduate's degree or some equivalent diploma, that it is of equal importance that every official who has to do with land administration should have learned by practical experience the conditions prevailing upon the land with which he will have to deal, that he should be familiar with its agricultural system, with the character and customs of the people upon it, with the methods and principles on which the record of changing facts and circumstances is maintained, that in this view the experience of the large peripatetic staff employed throughout the empire, to the number of several thousands, on duties which ensure the requisite experience, should not be thrown away, that no opportunity should be lost of drawing from its ranks selected men of proved excellence for service in the higher

nity of promotion to the upper grades of official service, there will, in the opinion of the Government of India, be no need to fear that the field service will fail to attract candidates of high educational attainments

Such a result would be desirable in the interests alone of the maintenance of a correct land record and of the proper training and control of the village subordinates by whom it is maintained, but it has an even higher importance in securing the efficiency of the higher official service upon which the conduct of the land administration of the empire mainly devolves

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on duties which ensure the requisite experience, should not be thrown away, that no opportunity should be lost of drawing from its ranks selected men of proved excellence for service in the higher appointments, and that in order to give effect to this policy, the educational standard of the peripatetic staff must be gradually so raised as to guarantee the intellectual fitness of the men who are to be drafted from it With the advance of education increasing competition for pensioned employment, and a widening opportunity of promotion to the upper grades of official service, there will, in the opinion of the Government of India, be no need to fear that the field service will fail to attract candidates of high educational attainments

Such a result would be desirable in the interests alone of the maintenance of a correct land record and of the proper training and control of the village subordinates by whom it is maintained, but it has an even higher importance in securing the efficiency of the higher official service upon which the conduct of the land administration of the empire mainly devolves

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... temporarily included,
... information ... permanent
... mary duty of the directors of agricultural departments The question was one of the most important discussed at the recent conferences

2 The opening Resolution of 1881, in which the duties of the new departments were first described, explained that an examination of the Famine Commissioners' recommendations in connection with agricultural enquiry showed that their final object was to urge, as a practical outcome of an intelligent scheme of investigation, the policy of maintaining agricultural operations at the highest attainable standard of
... e prevention
... nprovement,
... agricultural

defect, then to discover its cause, and, finally, to devise such protective arrangements as may remove or alleviate its injurious action. As an important illustration of the character of the investigation which was to be made, the examination of each agricultural tract in respect to its liability to suffer from drought on the one hand, or the extent to which it was or could be protected from drought, on the other, was suggested. The whole scheme of investigation was afterwards briefly designated as 'district analysis.'

3. The form in which the programme of investigation was put forward in the 1881 Resolution and the special attention which was drawn to the desirability of mapping out the tracts of a province in relation to their liability to failure from drought led in [illegible] as assumed [illegible] on of each [illegible] the liabi- [illegible] the design [illegible] ence and extent of each defect, the utmost use should be made of the information which the land records could be made to yield Thus, while in many parts of India excellent reports, maps, and atlases were published in illustration of the general condition of each district, no precise enquiry was set on foot as to the agricultural circumstances of each village or group of villages, as to the particular defect or defects which prevented each locality from reaching 'the highest standard of agricultural efficiency', or as to the possibility of remedial action in each case.

4. The enquiries, however, that were actually made in some provinces threw much light on the position. They proved that, notwithstanding the hereditary experience of the Indian cultivator and the special knowledge which he possessed of methods and appliances suited to the locality in which his crops are raised, many defects do exist in the agricultural condition or system of almost every district which, if they cannot be altogether removed, can at least be considerably modified and lessened. At the *agricultural conference of 1890 which met Dr. Voelcker before his* report was written, the necessity 'of laborious investigation before we can trace out the causes which have stimulated development in some parts of India and retarded it in others' was pointed out, and the advantage of utilizing village records as a basis for detailed enquiry was urged Dr Voelcker's report went far to prove the existence of innumerable defects in agricultural conditions and practices, and the importance in many cases of an intelligent analysis of facts and statistics, and of well-organized enquiry from village officers. The conference which reviewed Dr. Voelcker's report in 1893 took the same view

5. So matters stood when the subject was brought before the recent conferences for consideration and discussion It was

'failure to reach of occasional, (2) it was to be the object of the whole scheme of enquiry to minimize agricultural distress and agricultural loss in each class of cases; and that the first step was to decide how far the land records machinery could be utilized in the investigations under each head.

(1) *Occasional failure* was explained as "sudden distress due to unforeseen calamity, such as failure of rain, hail, storm, inundations, etc., requiring, as a rule, immediate relief." In these cases the land records are of primary service to district officials as indicating the extent and character of the calamity. The functions of the director of the land records department are confined to organising or to suggesting how to improve the system under which prompt and continuous information supplied [illegible] responsible authorities [illegible] given to the system. It [illegible] action. The examination which was made at the recent conferences of the measures which have been taken in the last few years to utilize the land records for this purpose proved that the system now established in every part of India in which land records are maintained is excellent, and that the results have already been most satisfactory.

(2) *Gradual failure* was explained as 'gradual deterioration due to ascertainable causes requiring early and special measures of prevention and relief.' Considerable distress had been known to have occurred in many parts of India in consequence of neglect to relieve the population of agricultural tracts which had suffered [illegible]

[illegible] necessary for indicating the serious deterioration of any agricultural tract and it only remains to make provision for such a clear and [illegible]

[illegible] the most important results of the recent conferences has [illegible] practical adoption of this plan. In every part of India, [illegible] is now to be kept up [illegible] figures [illegible] to show at [illegible] village; [illegible], for instance, as the cultivated and irrigated area of the year, the arrears outstanding, the sales of mortgages of land, and so on. Half an hour's examination of a circle book thus kept will indicate once whether a village or group of villages is declining in cultural condition and this fact known, the cause of failure is ascertained and remedial action suggested. It is important

spected by some responsible district official, so that within very few

dependently of the advantages of the system for purposes of current administration the series of circle books thus maintained will form an historical record of great value to officers who may be hereafter called upon to revise the assessments of land revenue Directors of departments of land records and agriculture should be instructed to consider it one of their chief duties to ascertain that the circle books are punctually and intelligently examined in every district. On the other hand, district officers should be required to communicate to the Director, for entry in his office ledgers, the proved existence of any serious agricultural deterioration that may have occurred in a locality.

(3) *Persistent failure* was defined as failure to reach the highest attainable standard, due to causes or defects of a more or less persistent character, and requiring prolonged investigation. Such causes or defects are, it was explained, want of irrigation, frequent liability to failure of rain, insufficiency in the wood or fuel supply, cattle diseases, plant diseases and blights, want of drainage, the prevalence of saline efflorescence, proved imperfections in agricultural practices, the want of suitable manures, and so on.

6. It is to this class of cases that Dr Voelcker's report chiefly refers Many of the defects such as those enumerated demand scientific enquiry by experts including experimental investigations on the departmental farms or on the estates of the Courts of wards or of landlords willing to assist in the work. This branch of enquiry will be dealt with in the succeeding Resolution. But the land records and the land record establishments can often be utilized for providing a basis for more detailed enquiry. Thus, the distribution of irrigation, the character of the rainfall in each tract, the extent of the wood supply can be ascertained from the records themselves Information as to the occurrence of particular cattle and plant diseases, the areas affected by the outcrop of salts, facts as to agricultural practices, and other agricultural matters can be attained by well-organized enquiry from the circle and village officers, to whom a series of questions bearing on the subject under investigation may be circulated.

7. Th[illegible] importance [illegible] record es- [illegible] yield The plan of enquiry must, however, in each case be worked out by the director of the agricultural department with the assistance of the experts placed at his disposal, and whatever system be adopted, the work is one which in its broader aspects must extend over periods of many years The necessity for detailed enquiries will

probably never cease Whether in the working plan which is to be laid down enquiry at any one time should be limited to one or two subjects was a question which was discussed at the recent conferences, but will be dealt with in the succeeding Resolution. What the Government of India desire now to insist upon is that, whatever may be the agricultural defect which is brought under investigation, the officers of the agricultural department should, as a first step, consider how far the land records and the establishments maintaining them can be utilized for providing information necessary to the enquiry.

8. Although the relation of land record establishments to famine administration was not included among the questions placed before either the conference of 1893 or those recently held, it must not be forgotten that one of the objects with which the Famine Commissioners recommended the organization of those establishments as well as of the formation of provincial departments of agriculture and land records was in order that the administrative and executive officials responsible for dealing with famine might at all times have at their command both the fullest information regarding the condition of every agricultural tract and the people upon it, and in seasons of scarcity be provided with a well-organized agency through which, in the first place, continuous intelligence of the state of every village and every suffering person in it would be communicated to them and in the second place, direct relief could be in case of need administered under their direction. These first objects of the land record machinery were fully considered in the famine codes drawn up in 1882, immediately after the constitution of the new departments had been directed Fortunately, since those codes were first issued no serious famine or widespread scarcity has until now afflicted the country, and time has been thus given to bring the establishments into good working order Their utility has indeed been partly proved on the occurrence of sporadic distress in limited areas during the past 15 years But full evidence of the immense advantages foreseen by the Famine Commissioners, resulting from the existence of a well-organized "intelligence department," has only been brought now before the Government of India

9. The key note of the system is the division of the whole country into easily managed circles of 50 to 100 villages each It has been estimated that in the temporary settled provinces there is at the present time at the disposal of the district officers an army of some 200 000 village officials who form a well trained and disciplined rank and file, commanded by a staff of 5,000 or 6,000 circle inspectors, who may be well compared to the commissioned officers of regiments The duties laid down for the latter in the famine codes and by provincial rules are that in ordinary years they should [illegible] est information and [illegible] conditions of every [illegible] n recent years been, so far as circumstances have admitted, well performed, and that in times of famine they should at frequent intervals visit every village

and, if necessary, every house for the purpose of ascertaining whether any person or persons are suffering from want of food or from sickness, whether relief is distributed in accordance with directions received, and whether private charity is encouraged and organized, that they should promote the employment of labour on agricultural operations, invite applications to construct wells and other agricultural improvements, make known the places at which relief works are opened, the nature of each work, and the classes of persons to whom such work is open, conduct the distribution of gratuitous relief to persons unable to leave their homes, report on the price of food, the state of the people and cattle, the condition of the water supply, and generally bring to the immediate notice of the district officials any occurrence deserving attention In the performance of these duties each circle inspector has, to aid him, some 20 to 40 village officers

10 Under the stress of the present calamity by which so many provinces of the empire are afflicted, the services of the land record establishments have proved of the greatest value, and have materially reduced the difficulties which on former occasions of famine resulted from the absence of organized machinery.

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example, the economic products of two adjacent provinces are to a material degree the same, the exceptions forming but a small , again, may be due to ld be a waste of labour by scientific experts as to the botanical character of the same plant in two contiguous areas or that the bacteriological origin of an epidemic should be sought for at great cost to the State at every provincial centre Such work can be done once for all at one place for at least a group of provinces

The *second* consideration is the importance of securing first class experts for purposes of scientific research The value of petence and qualifications of the in which conditions vary much In view of this circumstance and oviding every province with a staff of first class and highly paid experts in each branch of scientific research, *it becomes necessary to place scientific investigation, as a rule, under central direction.*

The *third* ist be conducted on The development sional and partial initiation of individual governments In the despatch of 1890, already quoted, it was shown that the distribution of scientific research has hitherto been unequal, both in relation to the sciences represented and to the areas covered by it, partly because no authority had been made responsible for initiating research in new fields, and partly because action taken in one province had not been taken in others. Systematic botany, for instance, in some provinces, and systematic geology throughout India, have been strongly represented for a long series of years, whereas the study of the useful and economic products of the country and the practical investigation of minerals had until very recently been neglected, while in some of those fields in which modern science has in recent ars been working in Europe, such as for instance that of cteriology, research has hardly commenced

3. In accepting the responsibility for the general direction and ntrol of the scheme of national research, the Government of dia have no desire to exclude the co-operation of local Governents and Administrations They would, on the contrary, wish to n their advice and assistance at every important step that may en towards the development of the scheme, and to receive for ble consideration any suggestions for initiating or extending research, of which the importance may be shown. Nor ise, whenever circumstances may admit, to transfer ached to an imperial department to the temporary or ol and direction of the provincial authorities Effect has cent years been given to this policy by placing officers gical and botanical departments for a definite period orders of a local Government, and again by arranging services of certain officers of the meteorological department

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should be shared by the imperial and provincial authorities. Thus the national character of the scheme of research does not altogether preclude provincial independence and co-operation.

4. In 1881, when the orders of Her Majesty's Secretary of State were received for the creation of agricultural departments upon which the responsibility of organizing a scheme of enquiry was to be placed, the position was found to be this.—Geographical exploration was in the hands of a large imperial department of survey, geology was represented by a well equipped staff of imperial experts, research in systematic botany was confined to Bengal and the North-Western Provinces. A meteorological department comprised one imperial officer and four officers partly imperial and partly provincial. Astronomical, magnetic and solar observations were shared by Madras, Bombay and the Government of India. Forestry was represented by provincial and imperial departments. No other science found a place in the scheme. Since 1881 material expansion, sometimes of the investigating staff, sometimes of the programme committed to them, has been effected. A brief account will now be given of the measures which have been taken for the development of enquiry in each field of investigation since that year.

5. *Geography* was in 1881 represented by a well equipped and important survey department, of which the cost to the State considerably exceeded 20 lakhs a year. The programme which it had undertaken was a large one, and may be briefly described as the trigonometrical, the topographical, and the cadastral surveys of India. In 1881 the first of these great surveys had almost approached completion. Considerable progress had been made in the second, while the third was shared with local Governments, each of the presidencies, for instance, having separate cadastral departments of a professional character. At the same time the recently introduced policy of financ[illegible] tendency in many provinces to [illegible] non-professional establishment [illegible] provincial maps could no longer be accepted for embodiment in the geographical charts of the professional department.

Previously to 1881 financial considerations had required that imperial expenditure on geographical survey should be reduced. An immediate limit of 20 lakhs had been laid down. But the sudden reduction of a long established service was found impossible, and shortly after 1881 the alternative was adopted of diverting a large portion of the staff from unremunerative to remunerative work. The latter was found in the detailed surveys of forest and [illegible]

stations of the trigonometrical charts, as a basis for the field or [illegible] was asked at [illegible] the local [illegible] ent in the Central Provinces, where almost the entire survey was conducted on

these principles. Partial effect was given to it in the North-Western Provinces, Burma and Assam. Nothing could be done in provinces in which, as in the Punjab, cadastral maps were approaching completion by a well trained local agency, but, on the other hand, in provinces where the local agency had not been trained, much of the field plotting itself had to be done by the professional surveyors.

The advantage to geographical science of the system advocated is that wherever the field maps have been thus professionally connected with the trigonometrical stations, new topographical details, entered from time to time as changes in the features of the land surface may require in the field maps, can be at once transferred to the geographical charts.

Simultaneously with the development of the large geographical scheme, as represented by the three important branches of survey, other scientific work, such as tidal observations, latitude investigations, and cartographical development, has been carried on by experts of the department.

In the meantime the staff of the imperial department has been gradually reduced, and will, as the demands on it diminish, be brought under further contraction. At present the recent annexation of Upper Burma, the development of the North-Western frontier, the opening of a cadastral survey in Bengal, the new requirements of forest departments, and the uncompleted portion of the topographical scheme in the older provinces, form an extensive programme, for the execution of which large establishments are still required.

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the study in detail of the mineral resources of the country, still to hold the first place, but a small section of the officers employed, including, whenever required, experts imported for temporary employment, was set apart for the special examination of mineral fields. Changes were made in the rules under which recruits admitted into the department were required to undergo practical training in mines or in laboratories. At the same time the principle of decentralization was so far adopted as to admit of the services of a geological officer being temporarily transferred for sufficient reasons to any provincial Government. Recently an inspector of mines has been attached to the department.

7. *Meteorology* was, in 1881, represented partly by an imperial and partly by provincial departments. The Famine Commissioners laid much stress on the promotion of meteorological enquiry. It was, they wrote, of primary importance that meteorological observation should not only be maintained in complete efficiency, but
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Previously to 1881 financial considerations had required that imperial expenditure on geographical survey should be reduced. An immediate limit of 20 lakhs had been laid down But the sudden reduction of a long established service was found impossible, and shortly after 1881 the alternative was adopted of diverting a large portion of the staff from unremunerative to remunerative work. The latter was found in the detailed surveys of forest and of agricultural lands For this purpose local Governments were invited to permit the professional parties to lay down for each district a skeleton map which should be scientifically connected with the stations of the trigonometrical charts, as a basis for the field or cadastral maps plotted in by the cheaper agency, and were asked at the same time to utilize the survey officials for instructing the local surveyors This policy was carried out to its fullest extent in the Central Provinces, where almost the entire survey was conducted on

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7. *Meteorology* was, in 1881, represented partly by an imperial and partly by provincial departments. The Famine Commissioners laid much stress on the promotion of meteorological enquiry. It was, they wrote, of primary importance that meteorological observation should not only be maintained in complete efficiency, but also so strengthened and improved as to ensure the early and punctual supply of information to officials and to the public of weather conditions and prospects. Protection against famine, the safety of

shipping, warning against floods, were objects to be held in view Since 1881 the department has been materially strengthened A second European expert has been attached to the central office A complete system of warning signals has been established along the coasts The number of observing stations has been considerably increased inland. Information is brought by telegraph from 11(instead of as formerly from 50 of the principal stations, detailed statistics illustrated by charts are daily despatched by post, and n abstract of them by telegram, to every part of India. The character and causes of meteorological phenomena which occur on the continent or on the adjacent seas are being carefully worked out

The provincial officers, who have other local duties not con

plementary details as they may require

8 *Botany*, like geology, is a science which has been officially represented from the earlier years of the century But, as was long the case in Europe, investigation was confined to the field of syste-

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occupation of most men with scientific training and tastes, much had been done independently of official agency by medical officers and others in many parts of India But no organized scheme had ever been worked out for the whole country In 1881 two officers, one at Calcutta and one at Saharanpur, were officially engaged on completing the botanical survey of Indian plants, but their labours were practically restricted to the two provinces of Bengal and the North-Western Provinces in which they were located In 1885 a third officer was, at the request of the Government of Madras, attached to that Presidency. Thus, of all India, only three provinces were included in the area of botanical enquiry.

In 1890 the Government of India, in communication with the Kew authorities, expanded the scheme of botanical investigation The Calcutta officer was placed at the head of a 'botanical survey of India,' the entire empire was, for the purposes of the survey, divided between the three experts, with the occasional assistance of a fourth in Bombay, botanical investigation was to take, as far as possible, a practical direction, and the officers of the provincial departments of agriculture were to co operate with the botanical officers in arranging working plans of enquiry.

Whether in view of the needs to be met in other branches of scientific investigation the staff employed on the botanical survey of India can always be maintained at its present strength, is a question which is still under consideration.

9. The *economic products* of India had not previously to 1881 been brought under systematic investigation Much scattered information had been embodied in official and private publications, in

scientific journals and the like, but was of little practical use, because it had not been collated and published in any accessible form ... of the various requisitions made ... India, on behalf of a series of in... h the Indo-Colonial Exhibition ... the duty of making a full col... a *catalogue raisonnée* which has recently been completed and published as a 'dictionary of the economic products of India.' The work has occupied 10 years In 1887 the appointment, hitherto a temporary one, was made permanent. The collections were placed in the national museum at ... e duties had ... to the col... making sup... products in respect to which information is wanting or incomplete

10. *Veterinary science.*—This includes the investigation of animal diseases, and of the means by which they may be prevented or cured. The enquiry is one of great importance to agricultural industry. The annual loss due to animal disease has been estimated in crores of rupees. It has indeed been officially stated by the local Government of one of the northern provinces that in the course of any five years the destruction caused by rinderpest alone was greater than that caused by drought.

Up to the year 1881 the only step taken towards serious investigation was the appointment in 1868 by Lord Mayo's Government of an important Commission whose report fully confirmed the necessity of further enquiry and of well organized measures No further action, however, was taken until 1890, when proposals were sanctioned by Her Majesty's Secretary of State involving the attachment of a veterinary officer transferred from the military staff to every province and of two officers with central duties to the imperial department of revenue and agriculture. A scheme was then drawn up for a so-called veterinary survey of cattle and of cattle diseases. The survey is primarily directed by one of the imperial officers who is engaged with the co-operation of the provincial officers in collecting and collating information throughout India regarding the various breeds of cattle and other animals useful to agriculture in the country and of the diseases to which they are subject.

11. *Bacteriology.*—Simultaneously with the veterinary survey investigation is being made as to the possibilities of preventing or curing cattle disease The treatment of many diseases is known and veterinary schools under the direction of the provincial officers have now been established at almost every provincial centre for the instruction of native practitioners. A lead in this direction had indeed already been given in Bombay, the Punjab and Madras. But no successful method of dealing with the most fatal and destructive epidemics, such as anthrax, rinderpest, and surra—a disease confined to hot and moist climates—had yet been discovered. Three possible systems of dealing with them had, from time to

time, been suggested which may be summarized as extermination, segregation, and inoculation. The first of the three, extermination of diseased or suspected animals, is *the method in which most* confidence is placed in European countries, but, owing to religious prejudices, is impossible in India. The second, segregation of infected animals, cannot be effected without *legislative measures* and a large staff of inspectors or police. Various proposals have since 1881 been submitted to the Government of India for legislative action, but have been, with the general concurrence of all local Governments consulted, condemned in view of the harrassment to the people and the great expenditure to the State that they would entail. The third measure, *inoculation*, which demands bacteriological investi[illegible] is, therefore, the only preventive mea[illegible] [illegible] cept indeed in those cases in which [illegible] *In this view the services of a com*[illegible] [illegible] Dr Lingard, were obtained from home, and a bacteriological laboratory was established at Poona. The climate, however, *not proving favourable for* laboratory investigation, the institution was transferred to a colder site in the Himalayas. In the meanwhile the character and causes of the destructive epidemic known as surra, of which the wide distribution had not hitherto been suspected, and which is due to a blood parasite, of which the life history could be worked out in any climate, were investigated [illegible] searches the expert on published have [illegible]

The Government of India is now considering the desirability of strengthening, by the addition of a second expert, the bacteriological staff attached to the *Himalayan* laboratory. *Rinderpest*, which was declared by Lord Mayo's Commission to be more destructive than all other diseases put together, and which is suspected to be probably amenable to vaccination, will be the primary subject of investigation. The enquiry is one to which special importance is attached, in view of the fact that it can only be conducted in a country in which, like India, the slaughter of suspected animals is not compelled by law. The discovery wherever made of an effective vaccine for rinderpest would, therefore, be a boon to every country in the world.

12. *Agricultural science* is a field in which provincial, as contrasted with national enquiry, can be usefully carried on. Indeed *most of the work* must be done by local observers and experts. Nevertheless it was deemed that, as urged by a conference of provincial officers in 1885, the services of a first class agricult[illegible] chemist of European reputation as an invest[illegible] problems of importance [illegible] out India, would, [illegible] considerable [illegible], in consultation with provincial office[illegible] *[illegible] inate scientific investigations, to initiate* enquiries, to c[illegible] g-plans for provincial farms, and generally to g[illegible] the course of experiment and to preserve c[illegible] was intended indeed to be little more th[illegible] of provincial departments

It was in pursuance of correspondence with Her Majesty's Secretary of State on this subject that Dr Voelcker was deputed by the Royal Agricultural Society of Great Britain to 'advise on the best course to be adopted in order to apply the teachings of agricultural chemistry to and in order to effect improvements in Indian agriculture' He fully confirmed the advice of the 1885 conference He gave a long list of questions which demanded scientific investigation, dwelt on the necessity of scientific advice to provincial departments, explained the advantage of central direction for the preservation of continuity, recommended that instruction in agricultural chemistry should be provided for national colleges of agriculture, and urged that 'general agricultural enquiry' could not be conducted without men who had made agricultural chemistry a particular study The conference which met Dr Voelcker in 1890 supported his opinion that an expert was required for purposes of scientific investigation independently ... on this advice the ... two experts—one ... xperiment and for lecturing in agricultural colleges, the other for the more important duty of guiding general agricultural investigation The valuable report which Dr Voelcker, himself an agricultural chemist had made on the general conditions and needs of Indian agriculture, gave sufficient promise that the measure would lead to the ultimate development of the sound working plans of scientific enquiry and experiment Two experts selected by Dr Voelcker, under whom they had served as assistants, were accordingly deputed for a term of five years Sufficient time has not yet been afforded to judge of the practical success of their mission

13 *Entomology* is a science which, as applied to agriculture, must be held to include investigation into the causes of all plant diseases The loss occasioned by diseases of plants is even greater than that caused by diseases of animals For instance, the value of wheat annually destroyed by the weevil alone is estimated at some crores of rupees As in the case of cattle diseases there are two distinct branches of enquiry—the one a survey of plant ... character of each, and the ... hem the other an investi... , and as to the possibilities of prevention or remedial action

Again, the diseases themselves must be classed under two broad divisions, *viz*, those which are due to insect pests of which the life history is known, or can with comparative ease be worked out, and those which are due to obscure blights, of which the origin and transmigrations are imperfectly understood

... ot been represented And since ... Government of India has had ... search in this field has been ... national museum at Calcutta, by whom a survey of the insect pests injuriously affecting agriculture was commenced in 1883 in correspondence and consultation

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while the character and causes of the destructive epidemic, known as surra, of which the wide distribution had not hitherto been suspected, and which is due to a blood parasite, of which the life-history could be worked out in any climate, were investigated by the expert [illegible] enquir[illegible] at Poona, and the valuable results of his researches [illegible] already been published.

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be said now to be experts, and for the most part their scientific investigations are carried out under the direction of the local Governments whom they serve. On the other hand the education of the European officers in the science of forestry is provided for at a college supported by the imperial Government in England, and of the native officials at a national school directed by an imperial

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officers and the forests themselves are periodically visited by an imperial Inspector General with a view to the guidance of the executive officials in the scientific investigations which are to determine the character of the trees adapted to each locality and climate and the appropriate treatment of them Finally, it is the task of the Government of India to formulate, in consultation with local Governments and the imperial experts, the broad principles upon which the scheme of investigation and development is to be based.

16 The share in the national scheme of the agricultural enquiry which devolves primarily upon the imperial authorities has now been explained, the measures taken, since the new department was created in 1881, towards the expansion and promotion of scientific and agricultural enquiry under central direction have been briefly described, and the position in which the programme now stands has been roughly indicated There are still many defects in the general scheme. It is still unequal and incomplete. What may be termed the older sciences—geography, geology, and botany—continue, for instance, to occupy a much greater share of the State expenditure devoted to scientific investigation than the newer sciences which comprise researches into the obscure diseases of animals and plants. Long standing departments have profited by the traditional respect which has been paid to them. Those of more recent birth have had to struggle against financial difficulties and against the opposition which is necessarily offered to anything new The Government of India have not omitted to take under consideration the question of equalizing the claims of each branch of scientific enquiry, and will as time goes on take such opportunities as may offer themselves of expanding investigation in the more modern fields of research

17. The Government of India cannot, however, work alone In view of the considerations which have been explained they are compelled to initiate and organize under central direction the various departments of national enquiry which have been described, but the work that is done in the field requires the active and sympathetic co operation of all local and provincial authorities As already indicated this principle has been recognized by the

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taken to explain to local Governments and Administrations the material aid which can be given to the development and to the effective working of the scheme by the active co operation and

intelligent advice of the provincial departments of agriculture. Already in the proceedings of the recent conferences the Government of India is pleased to observe that strong recommendations have been recorded in favour of promoting active research, in connection with the nature, prevention, and cure of plant diseases due to insect pests and other more obscure causes. So, too, at the agricultural conference of 1893 a request was made that botanical investigation might be made to take a more practical direction Appeals such as these for the extension and development of scientific enquiry from departments and officials who have the opportunity of observing in the course of their field duties the real needs of the [illegible] ie time assist the Govern- [illegible] of investigation in right [illegible] in organizing on a sound [illegible]

18 But the duties of agricultural departments will not end here. The officers of the departments should take every opportunity of working out, in conference and personal consultation with the expert investigators, a plan of operations and of assisting them in obtaining the facts and statistics which they may require Thus in the case of botany they should explain to the botanical expert when he visits or is invited to the province in what directions [illegible] locality Similar action may be taken in the case of minerals in consultation with the geological officers Again, they should make themselves acquainted with the measures being taken by the veterinary officers for the survey and study of cattle disease, and should assist them in obtaining the information which they may wish to collect from agriculturists They should bring to the notice of the reporter of economic products any facts and details which are likely to be of interest to him, and supply him freely with information under all branches of their work which it may be desirable for him to publish, they should bring to the notice of the forest officers or of the authorities responsible for the administration of land the needs of each locality for forest or fodder reserves, and should assist them to devise useful schemes by which requirements may be met. Above all, they should take the utmost advantage of the advice and guidance of the agricultural experts attached to the imperial department whose services have been freely placed at their disposal by the Government of India, and who themselves stand in need of the local knowledge and special experience which only the provincial officers possess

If during the next few years the active and intelligent co-operation of the provincial officers is thus accorded to the various departments and experts who are engaged in the investigations which directly or indirectly are required by agricultural interests, the Government of India are assured that, with the advice and assistance of local Governments and Administrations, they will be able to effect material progress in the great national work of scientific research.

FIFTH RESOLUTION.

SCIENTIFIC AND LOCAL ENQUIRY UNDER PROVINCIAL DIRECTION.

1. It is important to bear in mind that the creation of agricultural departments in India has been due to the occurrence of famines. The Commissions appointed on the occasion of two serious famines, in 1866 and 1878, to advise the Government on the action to be taken for the mitigation of distress caused by failure of harvests in the f
sure, the cre
scientific enc
increase of the food-supply of the country and to the greater stability of the agricultural outturn. The scarcity by which so many parts of the empire have, in the present year, been afflicted brings renewed importance to the main object for which agricultural departments were designed, and imposes fresh responsibility upon all local Governments and Administrations to give the fullest possible effect to the policy advocated, a policy which was explained in the Famine Commission's report of 1880 in the following words:—

'Our report,' they wrote, 'has clearly shown how greatly agriculture predominates over all other interests and employments
' ... shall keep pace with the increase of the population.'

2. In the opening Resolution of 1881, in which the programme of the new department constituted was set forth, the Government of India endorsed this view, they explained that the chief

defects was necessary before remedies could be provided to cure them, that the departments themselves must be made financially useful to the administration previously to embarking upon schemes involving material expenditure, that as it would only be through, and by, the ... ltural improvements could, on ... e country, measures must be ... proper system of intelligent instruction in the schools, but they agreed that when ... action had been taken to atta ... of the departments were to be ...

3 During the first few years after the constitution of the provincial departments the Government of India were content to know that the new establishments were devoting their main attention to the organization of the system under which agricultural facts and statistics were to be collected with a view to their utilization—firstly, for the introduction of remunerative reforms into the land revenue administration, and secondly, as a basis for agricultural experiment and improvement They proposed, however, that when sufficient progress had been made in this direction, renewed attention should be drawn to the main object for which the new departments were created And an earlier occasion than that now presented would have been taken to discuss with local Governments and Administrations the general plan on which agricultural experiment and reform should proceed, but for the desire of Her Majesty's Secretary of State that on a matter of such great importance to the country the opinion of an acknowledged agricultural expert should first be obtained It was in accordance with this view that Dr. Voelcker, the co[illegible]
Society, was deputed [illegible]
'the best course to b[illegible]
'Indian agriculture' Acknowledging the judiciousness of a measure [illegible] of extravagant
a[illegible] Government
o[illegible] antage of Dr. Voelcker's mission by inviting local Governments and Administrations to depute such officers and experts as might be most competent to assist him with their combined advice to meet him, on the conclusion of his first tour round India in 1890, at a general conference, the object of which was declared to be 'to secure the enunciation by the Government of India of those general principles which it is required to lay down in such form as will *primâ facie* be acceptable to local Governments' Dr Voelcker availed himself of the advice of the conference of the value of which he recorded his acknowledgments, in the exhaustive report which he submitted two years later and in which he recommended that positive action should be taken in many direct[illegible]
India considered it desirable that, [illegible]
mendations, or formulating princi[illegible]
conference of selected officers and experts from all provinces should be assembled in 1893 to discuss the measures finally suggested by Dr Voelcker The Government of India were thus constrained to await not only the recommendations of Dr. Voelcker himself and of the conferences which examined his proposals but also the views and opinions of local Governments and Administrations before endeavouring to formulate the principles upon which the agricultural reforms advocated by the Famine Commissioners should be attempted In order to ensure a full and careful consideration of the questions concerned conferences were held for a third time in each province during the recent cold weather. The time has now come when His Excellency in Council is in a position to announce the general plan upon which the provincial departments of agricul

ture should be called upon to base their efforts to fulfil the principal object for which they were designed and created.

4. There is, perhaps, no subject upon which more diverse opinions [illegible] under [illegible] been [illegible] xperience the methods best suited to their own soils and climate, that practices successful in the western are unsuited to the eastern hemisphere; that the lessons taught on an English farm have no bearing on the cultivation of an Indian field, that the labour-saving machines of Europe and America are useless in a country where manual labour is extraordinarily cheap; that interference with the indig [illegible] that, above all, offici [illegible] suited than any [illegible]

While admitting that these and similar arguments require that great caution should be exercised in framing official schemes for the improvement of agriculture in any part of the empire, the Government of India cannot allow them to be accepted as barring the prosecution of official effort. The time has indeed arrived when neither the imperial nor provincial Governments are justified in taking up any such position. Putting aside all other considerations, the strong expression given to opposite views by the two Commissions appointed by Her Majesty's Secretary of State to advise the Indian Government on these matters, *viz*, by the Famine Commission of 1880 and by the special expert sent out ten years later—views confirmed by conferences of selected officers and experts from all provinces—has practically taken the decision of the issue out of their hands. At the same time the Government of India are convinced on independent grounds that official direction [illegible], and indeed has been, [illegible] of importance It is [illegible] iberate policy put forward in 1881, and for the reasons already explained, the attention of agricultural departments in the provinces has been diverted from, rather than directed to positive agricultural reforms, that they have been urged to effect financial economies and to organize careful schemes of agricultural enquiry before entering upon a serious campaign in the field of agricultural experiment, that they have been told not to expect widespread results until the educational *system of the country has been improved* *Nevertheless in some* provinces, and notably in the two presidencies of Madras and Bombay, not only has considerable advance been made in establishing schemes of useful and scientific experiments under the direction of competent experts, but examples have been forthcoming of their financial value to the State and to the agricultural community. Failures have, it is true, been numerous, but, as pointed out at the Bombay Conference, a failure means at least success in setting a doubtful question at rest, while one financial success outweighs the cost of many failures A few instances noticed in the proceedings of the recent conferences or in Dr. Voelcker's report may be given of substantial and profitable results which, amid many failures, have followed agricultural investigations officially directed

5 (1) In 1877 a conference attended by officers of the geological and of the revenue and irrigation departments of more than one province, of whom two were the late and present secretaries of the imperial department of revenue and agriculture, was held in a district of the North-West Provinces for the purpose of discussing the possible methods of reclaiming lands rendered unculturable by an excess of salts There are in various parts of India, and especially in the north, several thousands of square miles of lands thus excluded from cultivation An elaborate scheme of experiments, including flooding, drainage, the application of chemical and other manures, and various methods of agricultural treatment, was laid down by the conference, and was carried out by experts of the agricultural and irrigation departments After some years, a system of treatment, within the reach of any enterprising agriculturist, was developed which admits of the profitable reclamation of saline lands hitherto condemned as unculturable. Although the widespread extension of the process of such profitable reclamation cannot be expected until the land owning classes have been so educated as to take spontaneous interest in the work, yet the results obtained have proved that a material addition to the cultivated area of the country can, in the course of time, be made, and that saline land once thoroughly reclaimed may be made capable of producing excellent crops It is estimated that every hundred square miles that can be recovered will, if, as is often the case, the land is within reach of the canals, produce annually upwards of a million of maunds of food grains

(2) In Bombay the Agricultural Department undertook the introduction of European methods of manufacturing dairy produce. A Swiss expert was imported and experiments were set on foot The following account of the results is given in the proceedings of the recent conference held in the Bombay Presidency 'No enquiry 'was necessary to prove the superiority of the English and continen-'tal methods What was essential was to popularize the improved 'methods and teach the use of improved machinery Local dairies 'were established at Poona and Bombay The demonstration was 'successful, and as success was secured the departmental dairies were 'closed Up to date about five lakhs of rupees worth of improved 'dairy machinery has been imported and the improved methods have 'spread throughout India Milk separators are now privately set 'up in villages on railway lines and the separated cream imported to 'cities where it is made up into butter whence it is largely exported 'to foreign countries The price of milk in out-lying villages has 'risen and milch cattle have increased in number'

The success obtained in Bombay led to the temporary transfer of the Swiss expert to the North-West Provinces, where within two or three years he was established on the very saline lands which were visited by the conference of 1877 and which have been since converted into a profitable dairy farm whence dairy produce is now exported to Assam Baluchistan, and other remote parts of India.

(3) Another experiment, initiated in 1885 at the instance of the Agricultural Department in a district of the North West Provinces, and referred to in Dr. Voelcker's report, has borne fruitful

results which have been recently noticed by the local Government. Land 'which was mostly a net-work of ravines affording grazing of the poorest description' was experimentally enclosed as a fuel and fodder reserve An expenditure of ₨3,000 has at the end of 10 years brought in an annual income of over ₨1,000 from the wood and grass raised in what had been, as Dr Voelcker observed, simply waste land There are, it is believed, several hundreds of square miles of waste ravine lands on the banks of the large rivers of Northern India, of which the reclamation would be of material advantage to agricultural interests, and the success of the experiment has already led to the extension of the system in similar tracts

(4) One more example may be given of material financial results obtained by investigations conducted on a scientific basis under official direction Between 1870 and 1880 careful field-to-field enquiries were made in the North-West Provinces and later on by the agricultural and canal departments in the Bombay Presidency as to the cost of applying canal irrigation to cultivated land These have led directly and indirectly to an improvement in the canal revenue of something like thirty lakhs a year not only without detriment to, but with distinct advantage to, agricultural interests, in view of the fact ascertained in both Provinces that the lavish use induced by unduly low rates of canal water on unmanured land leads to its deterioration

These illustrations will suffice to indicate that important
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necessary, that occasional success can only be obtained amid many failures, and that a long period of years is required for the definite ascertainment of positive results

6 The Famine Commissioners strongly insisted on the necessity of employing, under the general direction of the provincial departments of agriculture, competent experts trained at home 'There must,' they wrote, 'be employed a certain limited number 'of persons possessing superior technical and scientific knowledge 'of practical agriculture whose task it would be to aid the Govern-'ment in its endeavour to introduce improved methods of cultivation. 'These should be trained specialists, and their number might prob-'ably be at the rate of two or three to a province, and in all cases
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'up by—and this is essential—subsequent practical experience on 'a farm.' 'The reservation he added, as 'to practical experience is, in 'my opinion so important that it constitutes my reason for advocat-'ing the employment, at first at any rate, of European rather than 'native assistants, though it is quite possible that natives will 'occasionally be found with the necessary qualifications' The conference of 1893 endorsed this view in a resolution to the effect 'that 'it is essential ... rvement that 'there should ... hnical assist-'ant to the dir ... until natives 'sufficiently w ... e should be a 'European expert' They further urged that the expert should be supplemented by a staff of native assistants trained in this country, and that suitable institutions should be established for their education. The conferences recently held have in all the larger provinces supported the recommendations of the conference of 1893.

7. Influenced by this strong consensus of opinion, the Government of India have arrived at the conclusion that the time has now come when in every province in which no such arrangements have yet been made, a definite scheme should be drawn up under which a strong and efficient staff of agricultural experts will be within a limited period placed at the disposal of the provincial department of agriculture, and that, as recommended by the conference of 1893, unless and until natives sufficiently well-trained and qualified are available, the staff should include a European expert. They are aware that the present moment is one at which no avoidable expenditure on new establishments can be immediately proposed, and that they must at present be satisfied if a programme is arranged, with due deliberation and regard to future requirements, to be carried out as soon as circumstances admit But the very cause of present financial difficulties, famine, is in itself, as the Commissions of 1866 and 1878 have indicated, the strongest argument which can be used in favour of expenditure as soon as financial pressure is relieved of which the main object is increase of the food-supply, while the few illustrations which have been given of the financial and agricultural advantages which have already followed intelligently directed experiment, indicate the remunerative character of the outlay which will be incurred, and the ... e agricul- ... he seasons ... in future years.

8. These observations do not apply with equal force to all provinces. In the two presidencies of Madras and Bombay, for instance, the measures already taken or contemplated for the equip-

will be the full staff of agricultural experts and assistants which should, when circumstances admit, be placed under the control of the provincial department, in order to enable it to efficiently prosecute its primary and most important duty.

9. The employment of European experts and a trained staff of assistants involves the establishment of experimental farms On this subject nothing has been recorded in the proceedings of the recent conferences which affects the opinion of the Famine Commissioners and of Dr Voelcker that 'experimental enquiry conducted 'by means of experimental farms is a necessity in India for the 'development of agricultural improvement' To what extent experimental farms should be multiplied in any one province is a question which it must be left to each local Government to decide from time to time as the scheme of agricultural experiment is developed 'The 'decision must,' writes Dr Voelcker 'be partly based on considera-'tions of expenditure and staff but the main consideration should be 'whether there is anything definite to learn, a particular question to 'solve, and whether this has any relation to the agriculture of the 'country around' In the meantime the Government of India have no hesitation in requiring that the definite scheme for which they have called should include at least one central experimental farm adequate both in area and in the staff with which it is equipped to ensure the conduct of experiments on the system advocated by Dr Voelcker

10 It has been frequently urged that a single experimental farm in a large province is on account of the varying character of soil, climate and other agricultural conditions inadequate for the purpose of testing suggested improvements, for ensuring the applicability of methods more or less successful in one locality to other parts of the province, or for bringing useful results to the notice of the agricultural community of various districts It was partly for these reasons that Dr Voelcker advocated the establishment of supplementary 'demonstration farms' on which the results of useful experiments might be tested and exhibited The Government of India are not afraid to look forward to a time when native gentlemen and landlords under the influence of a well designed system of general education will undertake the expansion of experiment and demonstration on their own estates, but they trust that in the meantime the utmost advantage will be taken of the opportunity to [illegible] t manage- [illegible] ts This [illegible] who ad- [illegible] lightened [illegible] property by utilizing the results of science and adopting any well tested and clearly demonstrated improvement in methods of farming The Government of India have been pleased to observe that prominent attention has recently been called to this opening for the expansion of agricultural reform by the Lieutenant-Governors of Bengal and of the North West Provinces and they desire that the directors of the provincial departments and managers of estates under official control may in every province be required to give their earnest and

continuous attention to this plan of developing and testing all agricultural experiments which have in them any reasonable chance of possible success.

Where estates under the management of Government officers are not available, it may be desirable to consider Dr. Voelcker's suggestion of the establishment of demonstration farms.

11. The system on which experimental and demonstration farms should be conducted has not been examined at any of the conferences which have been held, nor in the opinion of the Government of India could any precise recommendations have been usefully formulated for general guidance. Dr. Voelcker's chapter on the subject offers many useful suggestions which should be carefully considered by the agricultural staff responsible for the conduct of experiment, but it must be left entirely to the officers of the provincial departments to decide, in consultation with the imperial chemist, what the detailed arrangements should be.

It is natural that these should differ in each locality. But there are certain broad principles noticed by Dr. Voelcker to which prominent attention may be drawn The *first* and most important is the necessity of a working-plan which, as in the case of forests, must be continuously maintained and, unless for strong reasons sanctioned by the director of the department, not interfered with until the experiments once set on foot have yielded definite results The *second* is 'that the issues in each case should be simple, 'and that the object of an experiment should, as a rule, be the only 'varying factor involved in it, in other words, that an experiment ... The *third* is that ... sible on an uniform ... ulated for general information

The framing of the working-plan and the system on which results should be reported are matters which should be arranged in consultation with the imperial officer who has been placed, with this object, at the service of the provincial departments.

12. When in any province the department of agriculture has been equipped with a European or equally competent expert, with a staff of trained assistants, and with an experimental farm or farms, a programme or working-plan will be formulated not merely, as above directed, of the experiments to be carried out on the farms, but also of the ... the defects in ... experimental ... n his report, gives a long list of *primâ facie* defects, to which the attention of agricultural departments should be directed, and it is known that many others exist to which Dr. Voelcker made no reference. The question how these should be dealt with has received prominent attention at the conferences which have recently been ... that it would ... made which, ... typical dis... ects for the

removal or minimizing of which remedial action is required, *secondly*, that when this had been done, enquiry and experiment should

[illegible]

known or suspected to interfere with agricultural prosperity This view commends itself to the Government of India who, while not desiring to restrict the power of the agricultural departments to expand their field of enquiry for good and sufficient reasons, think it desirable that local Governments and Administrations should understand that His Excellency the Governor General will be satisfied to know that at least one prominent agricultural defect is being subjected to searching investigation and experiment in each province.

13. The adoption of this view renders it inexpedient for the Government of India to attempt anything like a review of the numerous recommendations contained in Dr. Voelcker's report for the improvement of agricultural conditions. Taken one by one,

[illegible]

carefully studied by itself in all its bearings at the time when it is taken up The illustration given in the succeeding paragraph will explain what is meant by the term 'agricultural defect' and the general character of the enquiry and action needed in dealing with it.

14. The order in which defects should be selected for successive enquiry and experiment will depend on the conditions prevailing in each province and must be left to the discretion of the directors of the provincial department under the orders of the local Government. But the Government of India may point to one subject which, in view of its important and universal bearing on the agricultural outturn, they deem to deserve special attention in every part of the empire and which, if no reason to the contrary exists, they would be glad to see taken up as the first subject of enquiry in all provinces. The subject is this. In other oriental countries, *e g*, in Japan and in China, as well as in the western countries of Europe and America, manure provided by cattle and other animals is, as a rule, whether liquid or solid, strictly conserved. In India there are great difficulties in the way of preventing the latter from being used as fuel, but the former or liquid manure is mostly allowed to run to waste, and the practice of securing it for the fertilization of the field is hardly known. The results of scientific experiments in America have, however, and [illegible]
even greater than [illegible]
that the utilizatio[illegible]
the food supply of [illegible]
defined—'a negl[illegible]
within easy reach of every cultivator.'

The advantages of dealing with this particular agricultural defect are that any reform which can be effected does not involve serious outlay of capital, that it is one that can ... be carried out successfully in a trop... pean appliances, that the neglecte... of every cultivator, any increase in produce which can be effected by it is capable of indefinite multiplication

15 As the discussions at the recent conferences imply that some doubt has existed as to the system on which the investigation of agricultural defects should proceed and also provide some useful suggestions for a plan of enquiry, an indication will be given of the general method which may be followed in conducting an investigation into the subject which has been suggested for enquiry.

Firstly —Existing facts and practices must be ascertained. For this purpose local enquiries should ... the agr...

Secondly —A series of questions should be drawn up and circulated for reply to managers of Government estates, circle inspectors officers of the land record staff and other selected officials as well as to any intelligent landowners or farmers willing to take part in the enquiry, with the view of eliciting detailed information as to existing usages in every part of every district

Thirdly —A careful study should be made of the conclusions arrived at in America and Europe both as to the best methods to be adopted, and as to the actual value in increased outturn, of the application of liquid manure to various crops

Fourthly —The system in other oriental countries should be ascertained In connection with this and the previous quest on the imperial officer whose duty it would be to provide the required information should be consulted

Fifthly —A series of experiments should, in consultation with the imperial officer, be set on foot at the exper... farms, with the view of ... ces in other ... ultivator by ...

... methods promising *primâ facie* success have been worked out on the experimental farms, they should be subjected to more practical trial on estates under Government management or on the farms of intelligent landowners willing to accord co-operation

Seventhly —The progress made in the investigation in each province should be periodically communicated to the editor of the *Agricultural Ledger* for publ... journal in order that the ... may be kept informed ... being made in every ... in some provinces ... which would be of

general interest, have already been set on foot. An account of these should be published.

16. The defect which has in this case been suggested as the subject of general enquiry is the neglect to use a manure which is universally available, and the application of which would undoubtedly result in a material increase in the food-supply of the country. Th [illegible]
up, probably [illegible]
other enquiri [illegible]
one or two of the recent conferences, whether the policy of confining attention to one subject at a time is desirable, and whether it should not be left entirely to the discretion of the provincial agricultural departments to decide what the scope of their enquiries should be.

17. In order to prevent misapprehension on this point, the Government of India consider it necessary to explain that their intention is not so much to demand any rigid restriction of the provincial programme as to point out that the absence of any limitation of the field of experiment has in many provinces appeared to lead to indefiniteness and uncertainty in design, and to want of continuity in action, that enquiries commenced by one officer have been put on one side by his successor, that the agricultural defects and difficulties which have to be dealt with are, as indicated in Dr Voelcker's report and in the proceedings of the agricultural conferences, so numerous and grave that any attempt to deal with them simultaneously and exhaustively cannot, with the small staff at the disposal of the agricultural department, fail to prove embarrassing, that the investigation of any one subject must, if it is to yield successful results, be complete and thorough, that when a question has once been taken up for examination it should not be abandoned until an answer to it has been found, and that the programme or working-plan of the department must, however much or little it may be restricted, be at least clear and definite.

18 The Government of India have in the immediately preceding paragraphs been dealing with the complete and thorough investigation of large and important questions, and have not intended to refer to the working-plan of an experimental farm. The main object of such a farm is the trial of a long series of continuous experiments for the purpose in each case of proving a single fact. Here the working plan may legitimately include the simultaneous trial of as many experiments as the director, guided by his advisers and by the imperial expert, may determine to be eventually required for the broader investigation of any subject Thus, assuming that the question of improved seed grain is one which has been decided to defer for five years, there would, nevertheless, be every reason to ascertain in the meantime by continuous experiments on the farm [illegible]
make any material [illegible]
What would be d [illegible]
investigation into t [illegible]
district.

19 Subject to these considerations the discretion of the departments to expand the field of enquiry and experiment need not, especially in those provinces where an adequate staff of experts and assistants has been provided, be restricted by any absolute rule It would not indeed under any circumstances be desirable that the investigation of a single subject, such as that offered as an exemplar, should be carried to the end before a new question is taken in hand The time and attention which each subject demands must necessarily be greater in the first year or two of enquiry than in subsequent years when the most useful lines of experiment have been determined What the Government of India do wish to demand is that every agricultural department should always have before it for special and thorough investigation at least one agricultural defect of importance, and that if more than one are brought under enquiry at one time their number should not be so great as to lead to desultory and imperfect action in the case of any one of them.

20. In conclusion it must not be forgotten that an important factor in the success of the working of a provincial agricultural department is the qualification of the director himself This officer should, wrote the Famine Commissioners in the first part of their report, be chosen for his knowledge of the condition of the people and particularly of the agricultural classes, while in the second part they advised that a certain number of officers should receive a preliminary training at home before going out to India, and that meanwhile any officer selected should be allowed to spend a year or some longer period at a school of agriculture in Europe The Government of India granted this last permission, of which advantage was taken in two provinces, and in 1889 local Governments were asked to offer their opinion as to the manner in which junior officers could be best trained in future so as to secure a succession of efficient officers to an appointment which requires technical knowledge and special experience. The replies that were received were almost unanimous to the effect that the director should be an officer who had served an apprenticeship in the settlement department, and in view of the importance then attached to the organization of the land record system which was to form the basis both of land settlements and of agricultural enquiry, the Government of India were content to accept this decision. There seems, however to be no doubt that in some provinces questions of agricultural improvement have been too greatly subordinated by the director to land record work, and that, as suggested by Dr. Voelcker, the agricultural duties of the office have been practically neglected The Government of India are not disposed to press the view of the Famine Commissioners that training of a technical character in an agricultural college is necessary, though it certainly may be useful, for the qualification of a civilian officer to direct the agricultural department. If the department is equipped with a competent European expert and with trained assistants, the general direction of the department may, they think, be left to a carefully selected officer who has shown aptitude and inclination for the class of duties which the superintendence of the department involves

They are not, however, assured that in all cases sufficient consideration has hitherto been given to the agricultural side of the departmental programme in the choice of the officer to whom the control of the department is committed, or, as suggested by Dr. Voelcker, that progress in agricultural enquiry and experiment has not been hindered by too frequent changes in the incumbency of the appointment.

21. Akin to this important matter is the question placed before the recent conferences whether with a view to their co-operation in [illegible] improvement the [illegible] and in one prov- [illegible] has been given to the subject, it was suggested that all young officers should go through a short course at an agricultural college or farm during which they might at least learn something of the various crops raised in the province and of the general agricultural system which prevails in it. The question is one which deserves the consideration of local Governments and Administrations Among those 'who [illegible] ship may be chosen. It is of special importance, too, that now that settlement operations are coming under contraction, some steps should be taken to ensure the better qualification of a certain number of officials to co-operate in the scheme of agricultural enquiry. On this subject the Governor General in Council invites the further opinion and views of all local Governments and Administrations.

SIXTH RESOLUTION

Agricultural Education

1 The subject of agricultural education in country schools was one of those to which the Famine Commissioners, in their Report of 1880 advised that the attention of agricultural departments should be directed In the opening Resolution of 1881 the Government of India pointed out the necessity of securing the co-operation of the native community in working out any programme of agricultural improvement, and in correspondence which ensued with Her Majesty's Secretary of State on the general policy which should be followed by agricultural departments represented that no general advance in the agricultural system could be expected until the rural population had been so educated as to enable them to take a practical interest in agricultural progress and reform

2 These views were confirmed by the agricultural conference of 1888, which urged that the measure most immediately demanded was that of educating teachers competent to give instructions of the required kind, and in the same year the Government of India, dealing with the proceedings of the 1888 conference and with the report of the Finance Commission on the expenditure of the new department, issued a resolution in which a clear explanation of the general policy advocated was put forward. It would be the duty of every Government, it was urged, to ascertain by careful and continuous experiment and enquiry what improvements were possible, and during the long period of years which these investigations would occupy, to give serious attention to the education of the agricultural classes Extravagant expenditure on attempts to introduce improvements, until they had been thoroughly tested by experiment and until the agricultural population was prepared to receive them, was to be avoided. A resolution issued in the same year in the Home Department on educational policy placed a direct obligation on agricultural and educational departments in every province to work out a practical scheme of agricultural education.

No 345-55 C I, dated 20th March 1890

3 In one province, Madras in which an agricultural college *had been established for many years considerable attention had* been already given to the educational question, and when in 1889 a committee, appointed by the Government of the presidency to examine the working of the agricultural department and of the college, submitted its report, it was found that the conclusions arrived at pointed in the same direction 'It is to school and college 'education' wrote the Madras Government 'that the committee 'attach most importance, and more than half of their report is 'devoted to this subject' In view of the fact that the practical experience attained and the serious consideration given to the question for a long period of years in the Madras presidency

entitle the opinion of the committee to great weight, a brief exposition of their views, confirmed as they have been by the conferences recently held both in Madras and in other provinces, deserves a prominent place in this resolution. Their whole report indeed is one which merits the careful perusal and attention of all officers connected with the -

4. The main defects in tl
education were found to have l
in a college of high class, had no connection with the educational curriculum of primary and secondary schools, and was confined to students designed for agricultural employment either as officials or on their own estates The verdict of the committee was this
'We do not loo
'engaging in
'vinced that t

'We are persuaded that no means of increasing the efficiency of the 'Agricultural Department can be really effective unless the people 'are taught to understand what is defective in their present system 'of agriculture, where it is capable of improvement, and the best 'means to that end We believe that this can only be done, first, 'by extending their general education, i e, by teaching them not 'only to read, write and cypher, but to use their knowleddge so 'that they may, in however humble a manner, become thinkers, 'observers, experimenters * * * * Unless the intelligence of the 'cultivator be developed, and developed in such a direction as to 'lead him to devote a better trained intelligence to his own art, and 'to apply thought,
'concern his mater
'absolutely impossil
'change in a genera
'of this country may be enormously increased by improved methods 'of cultivation, by the introduction of new products, and by the 'rational treatment and development of stock Education is the

'are necessary and helpful to agriculture as educators, but they 'must fail to produce the greatest material progress possible, and 'secure that progress when attained, if the people remain ignorant 'and wedded to bad and, often, injurious methods.'

5. Impressed by the value of
were on practical ob
perfect system, the (
special notice of the
Secretary of State's
ference fully supported the Madras views. It urged the extension of primary education; the combination of agricultural teaching

with it; and the employment of students agriculturally trained in all departments of Government service in which an opening could be made for them. In convening the agricultural conference which was to deal with Dr. Voelcker's Report in 1893, the *Government of India again drew the prominent* attention of local Governments and Administrations to the subject; and, alluding to the request contained in the Home Department's Resolution of 1888, that the Educational and Agricultural Departments should be required tc [illegible] that 'it was e [illegible] 'Departments [illegible] s on, for [illegible] hichwill [illegible] cultural [illegible]

6. These views were confirmed by the conference of 1893, and in the Home Department's Resolution of 1894, reviewing the progress of education, the policy of '*making instruction in the rudiments 'of agriculture part and parcel of the primary system of instruction* 'in the country rather than teaching it as a subject apart from the [illegible] ressed upon the Educa- [illegible] as admitted that there [illegible] cy in the provinces to [illegible] practical direction.

7. Finally, in 1895 the Government of India decided to invite local Governments and Administrations to require the subject to be thoroughly examined in each province by a committee which should be composed of selected officers of the provincial, revenue, and agricultural and educational departments, and which an officer on the imperial staff should be permitted to attend for the purpose of providing facts and statistics from other provinces.

8 Hitherto general principles rather than actual practices had come under consideration. The leading objects of discussion were *now to be the positive ascertainment of any defects that might* exist in the present scheme of primary education, the extent to which effect had already been given to the principle of including [illegible] school cur- [illegible] *direction* [illegible] of obser- [illegible] Govern-ment of India took the opportunity [illegible] appended Resolution that the essential matter was not so much the adaptation of the educational scheme to the training of agriculturists as the framing of the plan of instruction so as to promote in the pupils taught the power of assimilating any kind of technical instruction; that the mere acquisition of knowledge was to be subordinated to the development of faculty, that the powers of observation [illegible] exercise, 'that the [illegible] por- [illegible] the [illegible] *will*

adapt the pupil for the subsequent of technical of any description. These views were supported by quotations from recognized authorities The late Professor Huxley had written that ' a ' system of education which does nothing for the faculties of observa- ' tion, which trains neither the eye nor the hand, and is compatible ' with utter ignorance of the commonest natural truths may be re- ' garded as strangely imperfect ' In a report of the Royal Commission on technical instruction it had been stated that ' while the ' system hitherto prevailing in English rural schools actually unfitted ' the children of farmers for an agricultural career, yet there was ' nothing in any scheme of rural education specially designed for the ' agricultural classes which should unfit the children for any other ' career for which they were specially suited ' The scheme was to be based, they said, on what a child could see round him, and it followed, therefore, as pointed out by the agricultural conference held at Simla in 1893, that ' any such system established in rural ' schools must, for whatever class intended, acquire an agricultural ' colouring because the surrounding objects are themselves ' agricultural '

9. His Excellency in Council has been much gratified by learn- [illegible] conferences and [illegible] Administra- [illegible] eption, that much has already been done to give effect to the principles embodied in them, and that the deliberations of the conferences are likely to lead to many important and practical reforms in the same direction It is interesting also to observe that since the discussions were held a strong movement has been made in the United Kingdom for legislation with the object of removing the defect, noticed in the Resolution of 1895, *viz*, the absence of any such preliminary training in primary and secondary schools as is required to enable the students to understand and assimilate the teaching offered in technical institutions

The conclusions arrived at in the course of the recent discussions will now be briefly explained.

10. The basis of the enquiry which the conferences were invited to make in connection with the adaptation of the educational scheme to the interests of agriculture was a series of recommendations which were recorded by the agricultural conference of 1893 and which grouped themselves under four heads —

I —Primary education.
II —Readers and text-books
III —Training schools
IV.—Higher education in agriculture.

These divisions may be conveniently taken under separate and successive consideration in the present Resolution

11. *I —Primary Education* —The definition of "primary education" adopted in 1886 by the Education Commission in their report was ' that primary education be regarded as the instruction ' of the masses *through the vernacular* in such subjects as will best

'fit them for their position in life and be not necessarily regarded a
'a portion of instruction leading up to the University,' and they
advocated that 'the standards of primary education be revised with
'a view to simplification and to the larger introduction of practical
'subjects such as native methods of arithmetic, accounts and men-
'suration, the elements of physical and natural science and their
'application to agriculture, health and industrial arts.'

12. The general principles thus put forward are in sufficient accord with the policy which as already explained, has met with general acceptance, but are, under the strict letter of the definition adopted by the Commissioners, only applicable to vernacular instruction. It would, in the opinion of the Government of India be unfortunate if this restriction were to be held to exclude an lower schools, in which education is commenced from the begin ning in English, from the material advantages afforded by a system of instruction based on principles which are almost uniformly accepted in all civilized countries, which were advocated by the Education Commission, and which now, after discussions extending over many years, have been strongly urged for adoption as a basis for all educational schemes by the general consensus of provincial authorities. In most of the provinces of India no such exclusion i possible. But the position is not the same in all.

13. The despatches received from Her Majesty's Secretary
of State in 1854 and 1859 on the subject of national education in
dicated that a distinction should be made in the educational cour
prescribed for the rich, middle, and poorer classesued to invite
In several provinces the same elementary inst quire the subject to
cular is provided for the younger pupils of a committee which
can be moulded into any form which the provincial, revenue,
siders to be best. The trifurcation comes la nd which an officer
eastern provinces, on the other hand, a separat nd for the purpose
for each of the three classes from the lowest sta ances.
stitutions as may adopt English as the languag ual practices had
elementary instruction is conveyed the course discussion were
determined not so much by the provincial authorit cts that migh
quirements of the course leading to educational the extent t
degrees. of including

14. The Education Commissioners represented that 'school cu
'tion was not called to this important variation in the directio
'scheme of different provinces until discussions on primary of obse
'had been closed, when it was too late to find time for its co Govern
'tion,' they took some pains, however, to marshal all the pend
ments on both sides, but stated that 'in the conflict of views,
'considering that no opportunity had been given of arriving at a
'definite conclusion, they refrained from expressing an opinion.'
They explained at the same time that by the system under which
the three courses were kept entirely distinct the main object sought
was 'to keep down the standard to the requirements of the masses
'and not to raise it by considering the wants of the well-to-do classes
'who are not, properly speaking, the masses.' The Government
of India have no desire to enter on the present occasion into any

detailed discussion of the merits of the two systems, but consider it expedient to point out that the reforms now suggested in the primary education of vernacular schools are in no way connected with the special wants of the well to do classes, that they are founded on general considerations equally applicable to every class, and that if they conduce to the better development of the intelligence of all children of whatever condition in life it would seem to be a question whether this advantage should be withheld from the well-to do classes The question is one which seems at least to deserve the consideration of local Governments and Administrations of provinces in which any class of school is excluded from reforms admitted into the general scheme of early education

15 Turning now to the position of primary education in schools —and in most provinces this means all schools—in which the plan of elementary instruction is controlled under the direction of the local Government, by the educational departments, it appears to have been ascertained in the course of discussion at the recent conferences that while in many provinces and notably in Bombay, material effect had been given to the principles advocated, yet that substantial defects did often exist which it would be desirable to remove The nature of the imperfections discovered and the character of the remedies suggested will be more easily comprehended if it is first explained what the plan of education ought to be if based on the principles supported at all the conferences

The first point is that in all schemes of practical education
designed to train pupils at an early age in habits of observation,
same directionand text books—which should deal, as far as possible,
discuss ons were hets—must be illustrated and explained by the con
United Kingdom for the objects themselves or of pictures and
defect noticed in the 'object lessons' play an important part in the
such prelim nary tr of every subject, whatever that subject may
required to enable tto the curriculum Even such an abstract 'sub-
teaching offered in may be elucidated by 'object lessons,' while in
The conclus 'knowledge of the commonest natural truths,' to
sions will now be xley s phrase, 'object lessons' are absolutely essen-

10 The bapoint is that all pupils should have the opportunity
to make [illegible]
to the [illegible]
which [illegible]
which [illegible]
a very advanced stage School boys have no time to
[illegible]

their subsequent career they can easily assimilate instruction in any subject or science which they may elect to take up

16 Three defects, involving important departures from the canons laid down in the preceding paragraph, were, in one province

or another, found to exist The *first* was that in the educational curriculum 'object lessons' are sometimes treated as a separate 'subject,' and not only so, but as an 'optional subject,' that is to say, pupils may choose whether or not they will learn 'object lessons' at all, and if they do so choose they study 'object lessons' as something apart from other subjects It has now been admitted at all the recent conferences that 'object lessons' should be treated as a 'compulsory *system*' of education and not as an 'optional *subject*' This indeed is how they are treated in Bombay and in some other provinces where readers and text books in practically all subjects are illustrated and explained 'by object lessons'

17 The *second* defect was that many pupils are debarred from attaining a knowledge of common natural truths and principles because the curriculum is so framed as to exclude the teaching of elementary truths and principles in any science or subject, unless

meaning of a map or plan' supplemented by 'making maps of the school room and its compound or by comparing maps of the village and of its surrounding fields with the facts on the ground' It is obvious that all boys whether they take up geography or not should be taught in this way the meaning of a map or plan, a proper comprehension of which is necessary for all professions, including agriculture, as well as for the ready understanding of all educational works which are illustrated by maps, plans and diagrams But under a curriculum which makes 'geography' an optional subject and gives to it exclusive possession of instruction in the meaning of a map or plan, a boy who elects not to learn geography is deprived of the opportunity of learning what a map or plan means

18 The same subject, geography, may be employed to illustrate the *third* defect, which is that for purposes of elementary education instruction in any one subject taken up is carried too far, so far indeed that time is not left for others equally important Thus boys who had taken up geography were found to be learning by heart the name and position of every county in England the advan-

the school they had gained over

ead maps and how to draw plans,

the disadvantage involved in the

waste of time devoted to acquiring knowledge practically useless to them

It was admitted at the conferences where the subject was discussed, that when once the principles of geography have been learned, and a knowledge of those geographical facts likely to be useful to the pupil through life has been gained, valuable time should not be lost in a wearisome study of details of which a knowledge does nothing to improve the faculty, and is otherwise of little or no positive use, that the time would be far more usefully employed in acquiring a knowledge of 'common natural truths' in other branches of science

19. It is not the intention of the Government of India to follow province by province the discussions which turned on these questions or to criticise the suggestions made in the direction of reform at each conference They deem it sufficient to observe that there seems to have been little difference of opinion on the questions raised ; that where defects of the kind described had existed the officers representing the education departments supported by the other members of the conferences have agreed to suggest appropriate reforms, and that the local Governments have in every case indicated their willingness to accord favourable consideration to their proposals.

20. On three points only do they consider that definite suggestions or remarks may be useful The first is this It appears to have been rightly assumed at the earlier conferences that the term 'elementary science' may be so widely interpreted as to include object lessons illustrating 'natural truths,' the meaning of a map or plan and other simple subjects of the kind, as well as the elements of botany, of zoology and of other so-called 'sciences.' Taking this view, they suggested that 'elementary science' thus interpreted should be a 'compulsory' and not an 'optional' *subject.* This was a step in the right direction. But at the later conferences it was advised that 'elementary science' should not appear in the curriculum at all as a separate subject, but be taught in school readers illustrated by object lessons, care being tak

should be omitted from the

This latter plan has already

of the Bombay Presidency and to a certain extent in that of some other provinces, and is commended by the Government of India for favourable consideration elsewhere.

21. The second matter to which attention may be drawn is of importance. In the educational despatch of 1854 Her Majesty's Secretary of State, quoting from the Lieutenant-Governor of the North-Western Provinces, stated that the land record system in 'Indian provinces' offered the stimulus of a direct interest for the

'The ultimate objects,' it was said, 'at which the education of an agri-'culturist aims are not all of them directly connected with the 'tillage of the soil. It is of importance to every cultivator that he

'and such simple surveying and mensuration as can be easily taught 'to any boy. It is equally desirable to bear in mind both that the

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17 The *second* defect was that many pupils are debarred from attaining a knowledge of common natural truths and principles because the curriculum is so framed as to exclude the teaching of elementary truths and principles in any science or subject, unless that science or subject is followed by the pupil to the very end of the school course Thus, 'geography' is in some provinces allowed to be an optional subject and the lowest or most elementary 'standard' in geography, *i e*, the 'standard' laid down for those boys of the lowest class in a school who take up that subject is 'instruction in the meaning of a map or plan' supplemented by 'making maps of the school room and its compound or by comparing maps of the village and of its surrounding fields with the facts on the ground' It is obvious that all boys whether they take up geography or not should be taught in this way the meaning of a map or plan, a proper comprehension of which is necessary for all professions including agriculture as well as for the ready understanding of all educational works which are illustrated by maps, plans and diagrams But under a curriculum which makes 'geography' an optional subject and gives to it exclusive possession of instruction in the meaning of a map or plan, *a boy who elects not to learn geography is deprived* of the opportunity of learning what a map or plan means

18 The same subject, geography, may be employed to illustrate the *third* defect, which is that for purposes of elementary education instruction in any one subject taken up is carried too far, so far indeed that time is not left for others equally important Thus boys who had taken up geography were found to be learning by heart the name and position of every county in England, the advantage which when they first joined the school they had gained over other boys in learning how to read maps and how to draw plans, was thus handicapped later on by the disadvantage involved in the waste of time devoted to acquiring knowledge practically useless to them

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21. The second matter to which attention may be drawn is of importance In the educational despatch of 1854 Her Majesty's Secretary of State, quoting from the Lieutenant-Governor of the North-Western Provinces, stated that the land record system in Indian provinces 'offered the stimulus of a direct interest for the [illegible] cational course. The conference of 1893 took up this question. 'The ultimate objects,' it was said, 'at which the education of an agri- 'culturist aims are not all of them directly connected with the 'tillage of the soil. It is of importance to every cultivator that he 'should be able to understand and interpret the meaning of entries 'in a cadastral map; that he should have proper acquaintance with 'the system of rural accounts; and that he should be able to read and 'comprehend the land records maintained by the official staff. For [illegible]

'for general purposes of education as any other kind of teaching. 'It is perhaps even more useful.'

The same arguments were pressed at some of the recent conferences. The plan had already been introduced in some provinces, among others, in Assam, where 'the advantage of teaching the 'people the use of the cadastral village map' was held by the director of the land record department to be 'very great, as gradually enabling them to become more independent of officials in arranging 'their own affairs' The Financial Commissioner of the Punjab, supported by the conference, went further in urging that, as the bulk of the po

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India, adopting the same view, have no hesitation in inviting local Governments and Administrations to require their educational officers, in consultation with the departments of land records, to

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22. The third matter which deserves notice is the position which 'agriculture' should take in the school course. Two questions were considered. One, whether 'agriculture' should be taught as a separate subject at all, or, like elementary science, be embodied in readers; another, whether, if admitted as a separate subject, instruction in it should be optional or compulsory.

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science ... readers illustrated by object lessons) in view of the fact, noticed in a preceding paragraph of this Resolution, that almost all instruction conveyed in

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In most provinces, however, it was considered that 'agriculture' and 'sciences ancillary to agric

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With these remarks the Government of India is content to leave the questions at issue to the decision of the local Governments and Administrations.

23. *II.—Readers and text-books.*—The distinction accepted at the recent conferences between 'readers' and 'text-books' was that while the former contain easy lessons on a variety of subjects, the latter

deal exclusively with a particular subject or science. The agricultural conferences of 1890 and 1893 laid much stress on the necessity of simplifying both readers and text-books The defects pointed out in school books dealing with elementary science and agriculture were that the language employed was often above the compre- [illegible] that the text-books sometimes aimed at carrying the pupil further than was necessary for any practical purposes.

24 The Government of India is pleased to observe from the proceedings of the recent conferences that a great deal has been done during recent years in almost all provinces to reduce these defects and that further attention is now to be given to the subject. The compilation of good readers and text-books for the young in connection with agriculture and sciences ancillary to agriculture is a task of which the difficulty is not always appreciated. In England the best text books on such subjects have often been written by men of the highest scientific reputation. In some of the continental countries they are compiled and issued under the supervision of the central bureau of the Government. In India, on the other hand, while there have been many useful books compiled for school use, no uniform policy has been adopted in their preparation, and [illegible] inequality in the [illegible] ks in various prov- [illegible] mer on this subject [illegible] agricultural expert, others have been based on these two books by educational officers, while others again have been independently compiled by non-officials. Evidence was given by a skilled witness at one conference that the current text-books on agriculture and other such subjects are quite unsuited for young learners, that they are too abstruse, and that they deal with chemical problems and other matters beyond the comprehension of the pupils.

25. Uniformity in India is impossible. Any attempt at precise uniformity in teaching was deprecated by the Education Commission. The differences of language; of climate and physical condition; of the natural objects used for oral lessons, or as illustrations of school books; of local customs and practices; all these are insurmountable obstacles to uniformity of text in readers and primers required for educational purposes. But it may be doubted whether these variations need stand in the way of a general uniformity of plan and system [illegible] quires a higher exercise of [illegible] dge in a form in which it [illegible] the young, and so far as [illegible] ol books demands the employment of the best intellects in the country for the work The question indeed has been raised whether the scheme on which elementary readers and text books relating to agriculture and allied sciences are to be framed should not be worked out and revised from time to time by a competent committee of educational

and other official experts who would, initially, deal only with the frame-work and general design of the educational books, leaving details to be filled in by provincial authorities, so as to suit the circumstances of each locality and who would subsequently offer criticisms on any defects which might present themselves to their notice in the completed books. The subject is, however, one which demands fuller consideration. At present the Government of India are content to record their opinion that readers and text-books
allied sciences should not only be
tandard of arrangement, simplicity,
but also that they should not fall
in these respects below the best standards in Europe, that it would seem difficult to attain this object unless some of the very best men available in the country are allowed to devote for a certain period the whole of their time and attention to the subject, and that the matter is one of such grave importance in connection both with the interests of agriculture and with the sound education of the people as to deserve deliberate investigation.

27. *III.—Training Schools* —The Conference of 1893 insisted on the necessity of
give instruction in the elementa
The conferences which have now
and that teachers should be trained to teach all elementary sciences on the system of
n many provinces lay stress on the
e system unless schoolmasters are
That something has been done in this direction has been admitted, but that, taking India as a whole, progress has not been sufficiently great is clearly proved. One obstacle exists in the fact that the teachers in the lower classes of schools are so poorly paid that they cannot in many parts of India be compelled to go through a course in training schools; another that even in the case of those who do attend the training schools, it is not always easy to provide for them at those schools competent instructors in what is really a difficult branch of a school master's work.

28. The desirability of instructing schoolmasters how to teach by means of object lessons and readers has been acknowledged by local Governments and Admi
decision as to what practical me
ing schools in this direction.
f the recent provincial con-
requiring training school
tment as masters, to pass
This measure had indeed

29. In Madras, where the subject has for some years been under discussion, it was proposed that training school students should go through a course under a competent agricultural master on experi-

farm and the experiments conducted on it for purposes of illustration. The Madras Government, while apprehending that a considerable time will be required to bring the scheme into operation, have accepted these views as sound. In the Central Provinces practical action has been taken in sending annually from each of the western districts four students or schoolmasters after they have passed

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trained were

the only efficient teachers of agricultural subjects and of cognate sciences in the schools The extension of the system was strongly advocated by the revenue officials on the conference.

30. In the North-Western Provinces a few students go through a two years' course at a Government farm, some of whom are understood to be designed for schoolmasterships, and the Alla-

ever, as proposed in Madras, and as is the case in the Central Provinces, trained by the educational, but by the agricultural department, and the course is perhaps too long and the numbers too few to have any wide influence on the educational staff

31 In Bombay, where special attention has been paid in the training schools to the practical instruction of teachers, one of the

ıltural teacher

recommended

ools should be

or the instruction of training school students was not raised at Bombay, but the principle has been accepted as regards training school teachers in the suggestion that the College diploma shall include a practical course on the Poona farm.

In Bengal the utilization of the Government farm for the purpose of training schoolmasters was recommended.

Thus, there is a decided movement which has already taken some positive form in the direction of according to schoolmasters a practical training in agricultural subjects.

results and feasibility. They invite all local Governments and Administrations to bring the quc

been done, under the serious cons

educational departments, and to

tural report of the year, what

subject.

33. *IV.—Higher agricultural education.*—The discussions on

evidence had yet been produced to show that students trained at them would find any satisfactory opening in life They held too that high-class educational institutions professing to teach such subjects as agriculture, forestry, veterinary science, etc., should be national rather than provincial; that one or two national colleges would meet the present needs of all India, that the colleges, if

at Dehra would satisfy the needs of all India.

34 Dr. V

directed to

separate inst

science were expanded by the addition of an agricultural branch. The conference of 1893 did not formulate any specific recommendation, but agreed with the conference of 1890 'that the claims of 'men trained in scientific agriculture to appointments in the revenue 'and cognate departments should be as freely recognized as those of 'men trained in law, arts, and engineering'

35. The question has now been put on a somewhat new footing by the argument urged in the three provinces of Madras, Bombay, and

and

an ag

well

order making the diploma in agriculture of the same value as a B.A. degree as a qualification for higher Government service. It was further pointed out at the Madras conference that the proposed measure of passing all training school students through a practical course on a Government farm would require a staff of training school teachers instructed in the more advanced branches of agriculture; and that in recent years ten per cent of the college students belonged to the land-owning class. The college was, therefore, needed—(1) for a large number of candidates for official employment, (2) for a certain number of training school teachers, and (3) for a material number of landowners.

36. It is evident that if the policy indicated is followed in other provinces there may be justification for a larger number of high-class agricultural colleges than the two advocated by the conference of 1890 The policy has been very strongly pressed in Bombay and is supported by the authorities there on similar grounds to those urged in Madras 'We want,' it was written in a note submitted to the Bombay Government, 'as officials in the 'districts, rather than technical experts, men who have had their 'thoughts directed to agriculture and whose minds have been

'taught to dwell on it, whose reports on the state of the crops, the 'imminence of famine or the condition of the agricultural population will be animated by personal interest and intelligence of 'things agricultural, who, when endeavours are made to help the 'cultivating classes by a State loan, distribution of seed, and so 'forth, or to stimulate them to adopt well tried improvements, will 'have their zeal quickened by sympathy with, and appreciation of, 'the measures proposed' The conferences in Berar and the Central Provinces followed the lead given in Bombay and suggested that students should be sent from those provinces to the Bombay College The Bengal conference, adopting similar views, claimed that the province was justified in having a college of its own, and recommended that the engineering college at Seebpur, near Calcutta, should be expanded for the purpose. The conferences held in the Punjab and the North-Western Provinces endorsed the arguments put forward in Madras and Bombay, but were prepared to advocate the establishment of one college for the two Provinces In Burma and Assam local conditions did not justify proposals for a high class agricultural institution in either province, though it was admitted that students might occasionally be sent to one or other of the colleges elsewhere Thus, the outcome of the deliberations of the conferences has been that there should be four high-class agricultural colleges, *viz* —at Madras, at Bombay, at Calcutta, and at some place in Northern India These four institutions would meet the ordinary requirements of Berar, the Central Provinces, and the Punjab, and the occasional needs of Burma and Assam The opinions of local Governments on the question will be separately invited

37. In every province which possesses or makes use of an [illegible] college there m[illegible]st [illegible]t has been urged, be a special [illegible] en provided in Madras [illegible] for elsewhere when [illegible] he question has been raised of establishing an agricultural degree at the University, in addition to the College diploma, and was, when the conference closed, under the consideration of the authorities

38 A subsidiary question was discussed at the conferences, whether in addition to the college there should be a school at which students should be trained for certain subordinate revenue appointments and for such posts as assistant managers on court of wards' estates, etc School classes have already been established at the Government farms in Nagpur and Cawnpore with this object, the Nagpur farm being also utilized by the educational department for the instruction of training school students and schoolmasters The period of the agricultural course is two years in both places, but the course for schoolmasters is at Nagpur only [illegible] consideration and which would be perhaps more satisfactorily worked out by inter communication, with the consent of local

evidence had yet been produced to show that students trained at them would find any satisfactory opening in life. They held too that high-class educational institutions professing to teach such [illegible] science, etc., should [illegible] two national colleges [illegible] that the colleges, if founded at all, must be equipped with a highly competent staff of teachers, and that the reduplication of the expense in every province would not be justified. Following this view, the 1890 conference considered that the agricultural college already existing in the Madras presidency and a second to be attached to the Forest School at Dehra would satisfy the needs of all India.

34. Dr. Voelcker [illegible] directed to agricultu[illegible] separate institutions [illegible] science were expanded by the addition of an agricultural branch. The conference of 1893 did not formulate any specific recommendation, but agreed with the conference of 1890 'that the claims of 'men trained in scientific agriculture to appointments in the revenue 'and cognate departments should be as freely recognized as those of 'men trained in law, arts, and engineering.'

35. The question has [illegible] by the argument urged in [illegible] better, for duties in the land revenue and cognate services; and that it is very [illegible] ined. This polic[illegible] ment, who have [illegible] ment order mak[illegible] as a B.A. deg[illegible] It was further [illegible] measure of p[illegible] course on a [illegible] school teach[illegible] culture; and that in recent years ten per cent. of the college students belonged to the land-owning class The college was, therefore, needed—(1) for a large number of candidates for official employment, (2) for a certain number of training school teachers, and (3) for a material number of landowners.

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Agricultural Education

APPENDIX TO SIXTH RESOLUTION.

Extract from the Proceedings of the Government of India in the Department of Revenue and Agriculture,—(No. 19—98-1, dated Simla, 20th September 1895)

Read—

Paragraph 25 of Government of India Home Department Resolution No. 199 dated 18th June 1868 on the Review of Education in India in 1880

Proceedings of the fifth meeting of the Agricultural Conference held at Simla in October 1893

Paragraphs 527 and 528 of Dr. Voelcker's Report on the improvement of Indian Agriculture

Paragraph 17 of Government of India, Home Department, Resolution No 2 dated 7th September 1894, on the Progress of Education 1887 88 to 1891 92

RESOLUTION

In paragraph 17 of the second Resolution mentioned in the preamble, allusion was made to the suggestions of Dr Voelcker respecting the education of the agricultural classes The subject has now to receive renewed attention in connection with the recommendations of the agricultural conference which was convened in October 1893 to consider Dr Voelcker's Report.

2 The general view taken by the Government of India in the Resolution of 1894 was that greater success is to be expected from making instruction in the rudiments of agriculture part and parcel of the primary system of instruction in the country, than from teaching it as a subject apart from the general educational programme, and that such general enlightenment and intellectual expansion of the agricultural classes as would enable them to perceive for themselves the small r[illegible] and opportunities, would be [illegible] results than special instruction [illegible]. This view is in practical accord with the opinions expressed by the delegates of Local Governments and Administrations at the Conference of 1893 In their second Resolution they recommend that, as a general rule, instruction in agriculture should be combined with the existing course of education and not depend on separate special institutions

3 The principles which govern the introduction of agricultural instruction into the educational system apply also to all branches of technical instruction The question, therefore, is not merely how to adapt education to the training of agriculturists, but how so to fashion the plan of instruction as to promote in the [illegible] g[illegible] easily any kind of technical [illegible]

have during recent years un[illegible]

more advanced countries of Europe. One great feature in the change has been the substitution of the idea of development of faculty for that of mere acquisition of knowledge It is now acknowledged that the hand and the eye should be trained, that the powers of observation should be brought into play and improved by exercise, and that the actual teaching of a particular trade is of less importance, in the first instance, than educational methods which will adapt the pupil for the subsequent reception of technical instruction of any description. "A system of education," writes the late Professor Huxley, "which does nothing for the faculties of "observation, which trains neither the eye nor the hand and is com-"patible with utter ignorance of the commonest natural truths, may "naturally be regarded as strangely imperfect". All technical instruction must indeed be founded on a preliminary training of a practical character in primary and secondary schools. In the reports recently submitted from various counties in England on the results achieved at technical institutions a common cause of failure was found to be the absence of any training of the powers of observation in the schools of lower grades. On similar grounds a [illegible]

[illegible]

mainstay of the prosperity and wealth of the greater part of the population of India, deserves, more than any trade or profession, the special attention and care of those who are responsible for the instruction of the rural classes, but they are convinced that the early school instruction which is most calculated to produce eventually the best agriculturists will be equally useful to those who intend to follow any other occupation.

4 At the same time the circumstances and surroundings of [illegible]

[illegible] The view recorded in the proceedings of the Conference of 1893, that any system of pra tical education in rural-schools must, for whatever class intended, acquire an agricultural colouring, because the surrounding objects are themselves agricultural seems therefore to be unexceptionable.

5. In the Resolution of 1894 on Educational Progress the Gov-

ernment of India have acknowledged that there is a general tendency to modify the course of primary instruction in the desired direction. In some Provinces material progress has been made. But they are not fully aware how far the principles advocated have been systematically adopted, or to what extent opportunities exist for their wider introduction. Nor have they been informed what action, if any, has been taken on the suggestion in the 25th paragraph of the Resolution of 18th June 1888 that conference [illegible]

with agriculture. But the time must soon come when this position will be changed. Serious discussion of the subject ought not to be longer postponed.

6. The Governor General in Council desires therefore that the suggestion of the Resolution of 18th June 1888 should now be carried out, and that advantage should be taken of the visit of the officer deputed by the Government of India to discuss the proposals of the Agricultural Conference of 1893 to hold in each Province a Conference of such officials as the Local Government may appoint, [illegible] cational and [illegible] the Resolu- [illegible] 1893 with [illegible] osals for the [illegible] on.

7. The Government of India do not wish, until Local Governments and Administrations have had the opportunity of recording their own views, to deal further with the specific proposals of the Conference, nor do they desire to authorize the officer deputed by [illegible]

earnestly examined in the interests of future agricultural development.

SEVENTH RESOLUTION

PUBLICATION OF AGRICULTURAL INFORMATION.

The despatch of Her Majesty's Secretary of State directing in

No. 65 dated 16th June 1881

their main objects was to be 'the
'statistics in order that Government and its officers may always be

2. The various agencies established or contemplated by which information facts, and statistics are or will be collected have already been described They have been brought under three main divisions—(i) Land record establishments, (ii) Scientific departments under imperial direction, and (iii) Provincial departments of agriculture and their experts The duties in respect to collecting and publishing information which devolve in each case upon the provincial and imperial departments, respectively, will now be considered

I.—Information derived from land records.

3 Information supplied by the land records and by the establishment which maintain them can be 'rendered available' in three ways

Firstly, in such form that th and be made to yield quired This has been, or now will be, effected in every province in which village records are maintained The system accepted at the recent conferences for providing a simple abstract of the facts and statistics for each village, which will at once indicate its progress or decline, has already been described in the third Resolution of this series And the whole scheme of land records has now been so arranged in every part of India which possesses land record establishments that information is promptly conveyed to the authorities of injury or distress caused by sudden calamities

Secondly, by the collation and review of the statistics for each district and division for the province and for the whole empire This duty is respectively performed for the province in the annual or periodical reports of district and divisional officers, in the review of them by the land record department, by the higher revenue authorities, and by the local Governments, and for the empire by the compilation and discussion of them in the statistical department of the Government of India, by which department they are published for the information of the general public of the home authorities and of Parliament

Thirdly, by the collection and collation of special facts and statistics under appropriate subject heads The method which is advised of arranging information under subject heads, with a view to its eventual publication in an intelligible form, will now be described

4 The system may be most conveniently described as a system of 'ledgering' and is an essential duty of the departments of land records and agriculture In every departmental office arrangements should be made for the separation of pamphlets, extracts, letters, reports, etc, referring to each subject which is of sufficient importance to deserve a distinct heading, in such a manner that all papers relating to that subject may be brought together for convenient reference If this principle is observed the details may be left to the discretion of the departmental officers But as the system is one which has been successfully elaborated in the office of the Reporter on Economic Products, that official has been instructed to publish a brief description of it for general information.

5 The Government of India have already indicated in the third Resolution of this series how the land records and the land [illegible]

diseases of agricultural plants and of cattle and so forth. Information thus directly solicited would be naturally ledgered under its appropriate head and published, if necessary, by the department or supplied to the scientific department which requires to utilise it

6 Beyond the information thus specially sought for there are many facts and statistics which are brought to the notice of district officers in their inspection of the records or otherwise, which are of sufficient interest to deserve compilation and perhaps eventual publication by a central office Thus, in the abstracts (to which allusion has already been made) of village statistics, (the occurrence of various agricultural defects in particular localities may be brought to light In one group of villages it may be the prevalence of a noxious weed, in another the continual recurrence of a plant disease, in a third the spread of saline efflorescence, in a fourth the appearance of an obscure cattle murrain. Some system should now be established under which district officers should be encouraged to communicate to the department of land records notes of any remarkable facts bearing on agricultural conditions which may come to t[illegible]
ably suffi[illegible]
directing [illegible]
[illegible] deterioration affecting a group
[illegible] should be sent to the office of
[illegible]

7. It will be presently explained that the system of 'ledgering' advocated will not require that any facts and statistics thus supplied need be immediately utilised by the central department of the province It will suffice that they should be recorded in their proper place, until the time comes when the subject to which they

relate is brought under special ... formation thus collected will, whe ... be of material use in providing t ... ondition of the country ' which H. Majesty s Secretary of State called upon agricultural departments to supply.

II.—Information published by scientific departments under imperial control.

8. The second agency by which ... published includes the ... ernment of India Some ... their publications being ... in communication with the imperial Government.

9. In every branch of work ... in executive operations is ... r information of more general ... the character of which will

In the *Survey* Department the maps and charts that are issued at the head office practically embody the greater part of the geographical information secured by Survey operations

The *Geological* Departme ... ing a detailed account of the ... made by its officers, and exhi ...

products.

The *Meteorological* Department is one on which the obligation to provide full and ample information for the use of officials and of the public was strongly urged by the Famine Commissioners. The measures taken, under the direction ... India to fulfil ... storms, tides and ... the meteorological department has given full effect to the policy which has been pressed upon it.

The *Botanical* Survey of India has recently commenced the issue of a series of 'records,' edited by the director, in which are embodied the results of the ... officers throughout India ... by the director under the ... open to ... re further ... roducts for ... their investigations may bring to light in connection with plants of economic value.

Economic Products have, since the Imperial Department of ... stituted the ... and publish- ... India In no department of science is information more required by the commercial and general public as well as by officials engaged in administrative work. As already explained in the fourth Resolution of this series, a descriptive catalogue under the title of a 'Dictionary of Economic Products' has been prepared and published by Dr. George Watt, the official reporter, its compilation having occupied ten years. But the dictionary was only designed to bring together facts and statistics already recorded in some form in books, reports, and journals, or in the manuscript papers of Government offices. The still more important work of collecting and collating new information has now been commenced, with a view to its ultimate incorporation in a revised edition of the dictionary, as well as to the current publication of so much of it as may be of immediate interest.

10. A scheme has been drawn up under which the current work is divided into three branches:—

(1) The compilation of 'handbooks,' which are practically revised 'dictionary' articles, relating to a limited number of economic products, about twenty, of which collections are annually sent to the Imperial Institute. The handbooks are designed for circulation and sale in England and other countries, as well as in India

(2) The issue of ... Ledger,' ... interest ... reporter on economic products) by any of the scientific or provincial departments. This series covers more ground than is occupied by economic products, including as it does notes on any subject connected with agriculture, but economic products, under which head ... well as for distribution to the public.

(3) The collection by the reporter of extracts from journals, from settlement reports, and other such sources of information, as well as of notes communicated from time to time by private or official contributors. These are ledgered in the reporter's office on a system which brings together all papers referring to the same subject in such manner that the information they contain can be readily utilised, and, if necessary, condensed, whenever the subject may be even- ...

to the commercial public is communicated in special circulars to those concerned in anticipation of more formal publication.

11. The heads of all departments, provincial and imperial, have already been invited to bring to the notice of the official editor any passages in reports and publications connected with their work which deserve to be brought to his notice for inclusion in his office ledgers or for communication to the public. The Government of India take the present opportunity to direct continuous attention to this useful practice, which tends to the preservation in an accessible form of much valuable information which would be lost sight of in the pages of reports on current administration or of other blue books which are relegated to the shelves of official record-rooms and seldom again consulted

12 In the *Veterinary* Department a system of ledgering similar to that employed in the economic product department is adopted When sufficient information of interest on any subject connected with cattle, horses, animal disease, etc, has been collected by the special officer who, as stated in the fourth Resolution, is charged with this duty it is communicated in the form of a number of the agricultural ledger series for publication by the official editor

The *Bacteriological* branch of the department publishes the results of its investigation in a series of special memoirs, which are issued whenever sufficient matter is available for publication In some cases these would be communicated to the agricultural ledger.

Information collected in the department of *Agricultural Science* is communicated in the manner already explained to the official editor of the agricultural ledger for issue in that series

[illegible] *tomology* memoirs are issued [illegible] ficer on the staff engaged in [illegible] ormtion collected by him is [illegible] in the agricultural ledger series.

General information about *Forestry* is conveyed to the public in an annual review published by the Inspector General of Forests while any detailed facts and statistics of interest are published in the agricultural ledger series A useful periodical entitled the 'Indian Forester,' to which Forest officers are the chief contributors, is utilized by the Department for conveying interesting information to the official and general public

In the department of general *Statistics* periodical reports, reviewing the statistics received from all provinces and departments, will now be published periodically by the Director-General of the newly constituted department These comprise, among others, monthly, quarterly [illegible] ports, on inland roac [illegible] and outturns. One [illegible] return of the agricul [illegible] Parliament

Independently of the new statistical department, the imperial

department of agriculture undertakes the publication, periodically revised, of a *statistical atlas* in which the circumstances and resources of the empire are illustrated by maps, statistical diagrams, and brief descriptive essays contributed by directors of scientific departments or by other selected officials The second edition of this work has recently been published

Art and *Industries*, though not represented by any separate imperial department, have not, in the scheme of publication, been overlooked An illustrated journal of Indian art, to which all officials and others interested in the subject in India or in Europe are invited to contribute, was, in the year 1888, brought out at the instance and with the aid of the imperial Department of Revenue and Agriculture by a well known London art publisher and is issued monthly A 'technical art series' containing illustrations of Indian art and architecture is also published by the officer in charge of the Photographic section of the imperial survey office Both of the above publications are partly designed for educational purposes as well as for preserving a knowledge of the best art of the country A third series, designated 'drawing examples' and also published by the Survey Department, contains a special selection of oriental art drawings for use in schools.

III.—Information published by Provincial Departments

13 The third agency upon which the duty devolves of publishing information, facts and statistics on agricultural and scientific subjects otherwise than in connection with land records, comprises the agricultural departments of the provinces and experts under their control.

14 The system of 'agricultural ledgers' adopted by the Government of India was taken from Madras, in which presidency for some years the practice of issuing 'agricultural bulletins' had been established There are many subjects of provincial importance which are too dependent on local conditions and circumstances to be of useful interest to other provinces or to the general public The maintenance of a provincial as well as of an imperial series of publications is, therefore, most desirable, and some other provinces have now followed the example of Madras, and the Government of India would be glad to see the practice adopted in every province.

15 Those papers in a provincial series which are of general interest outside the province are, under a scheme for provincial co-operation recently circulated, to be communicated to the editor of the imperial series for wider circulation, and in this view the pamphlets of both provincial and imperial publications are to be of the same pattern.

16. The Government of India cannot press too strongly upon local Governments and Administrations the desirability of encouraging the directors of agricultural departments to provide for the free and constant contribution of useful information to the imperial editor As explained under the previous sections, such information may be of two kinds, either for immediate publication in

the imperial series, or for inclusion in the ledgers of the editorial office With this object the agricultural department should, subject to the instructions of the Local Government, devise a system under which, as in the imperial departments, all passages in official papers and reports, of which the preservation for future publication may be desirable, should be marked and brought to their notice To no class of reports do these remarks refer more particularly than to settlement and land administration reports Much of the interesting information on agricultural subjects contained in them is lost to future generations of officials unless promptly extracted and ledgered under appropriate heads A schedule of the headings which should be adopted for this purpose has been elaborated in consultation with provincial authorities and is now in force throughout India

17 There is another class of facts and statistics in which the Agricultural Department is essentially interested and which especially demand a careful system of ledgering, *viz*, the results of experiments on Government farms or of investigations into agricultural practices and conditions These, which are often of a technical character and of interest only to those actually engaged
come within the scope of
ovincial bulletins But
red, may, as previously
usefully communicated
direct by one provincial department to another, and may, whenever of general interest be published in the provincial bulletins or communicated for inclusion in the ledgers of the imperial editor

Every provincial department must at least be required to include in the information thus communicated to other departments—

(1) a statement of the working-plan arranged in consultation with the agricultural chemist for every experimental farm and of the progress made in carrying it out each year in order that the officials of the agricultural department in each province may be kept punctually informed of the experiments, their objects and results, which are being carried out in all other provinces,

(2) a statement each year of the agricultural defect or defects which have been made the subject of special enquiry during the past 12 months and a report on the progress and results of the investigation,

(3) any remarkable facts which may at any time come to the notice of the department and which are likely to be of interest to the agricultural departments of other provinces

18 In the Bombay Presidency the system has been followed of publishing a statistical atlas, on the plan of the imperial atlas in which the conditions and circumstances of each district are illus-

trated by maps and statistical diagrams, and the measure is recommended by the Government of India for general adoption. Such atlases are of use and interest to the general public as well as to the administration.

19. The main principle which the Government of India conceive it necessary to bear in mind in the development of the scheme for recording facts and statistics is that the record of them in general reports dealing with a variety of subjects is of little or no practical use, unless those which are of interest are at once seized upon and preserved in ledgers under intelligent direction. The principle was accepted by the agricultural conference of 1893, and the Government of India trust that it may now, as far as possible, be carried into effective practice on a well-organised system by the departments of land records and agriculture in every province in which action has not yet been taken to this end.

EIGHTH RESOLUTION.

Annual Reports.

1. [illegible]

with wh[illegible] e, which was to be based upon the [illegible] had been definitely determined. [illegible] worked out by provincial departments has now been finally settled in communication with local authorities and Governments and is embodied in the preceding Resolutions of this series. The annual reports should, in the opinion of the Government of India, follow, as far as possible, the arrangement which has been observed in those Resolutions

2 The Government of India last dealt with the subject of [illegible]

conveyed and which had for their object the curtailment of annual reports. The paragraph referred to is quoted below for purposes of easy reference —

Paragraph 3 of Resolution No. 52, dated 14th September 1887.

3. *Report of the Department of Land Records and Agriculture.*—The annual publication in every Province of the Report of [illegible]

report consists of two main divisions—Land Records and Agriculture—and is designed to show the executive work of the Department, [illegible]

[illegible] submitted by the Department to the Chief Revenue authorities of the Province, for utilization in preparing the Land Revenue Administration Report and may prefer that for that purpose it should be included in the land record section of the Departmental Report, rather than be submitted by independent communication. There will be no objection to this course But there seems to be no reason why statistical statements concerning crops, irrigation, tenures, etc, should find a place in the Report of the Department as well as in the Annual Land Revenue Administration Report, to which latter they

should, in the opinion of His Excellency in Council, be confined The Agricultural section of the Departmental report should be restricted to an account of the executive operations of the Departmental officers, and to a brief description of, or reference to, any results of special
preceding twelve
estates, or otherw
cultural subjects
the working of gardens, farms, or other agricultural institutions which should be dealt with in the Department by orders on the annual reports. In accordance with the above remarks, His Excellency in Council is of opinion that no other review of the Annual Report of the Director of the Department of Land Records and Agriculture than that which may be included in the review by the Local Government of the Land Revenue Administration Report is necessary, and that it will suffice if a copy of the Report, together with any orders which may be passed thereon, is submitted for the information of the Government of India.

3. The question which remains for consideration is the arrange-

will hereafter be replaced by headings corresponding to the subjects dealt with in the Resolutions which are now issued in supersession of the Resolution of 1881.

4. The first Resolution of the new series is prefatory and requires no notice in the annual report. But it will be desirable that the annual report should commence with a prefatory chapter in which will be recorded, among other matters, a brief notice, any changes which may have occurred in the personnel of the Department, and a short description of the tours taken by the Director, and of their general object.

5. The second Resolution deals with the measures taken to improve land record establishments. The work of the department in connection with land records is in most provinces described in a separate report which is incorporated with the land revenue administration report *of the year. The Government of India have no* wish to interfere with this procedure, which is doubtless the most convenient to all branches of the administration concerned. But they desire that the annual report of the department should contain

stances of a general character which may indicate that the gradual improvement of the land record staff is held in view.

6. The third Resolution deals with the utilization of the land records. Under this head should be described the general working

of the system prescribed for the maintenance and inspection of circle note books, it should be explained whether, as a rule, they are

Resolution V or otherwise

7. The fourth Resolution deals with the scheme of scientific enquiry carried out by imperial departments Under this head the report should state to what extent during the course of the year the provincial department has lent its co operation to, or made use of, any one of the imperial departments named in the Resolution, and should describe any work done in the province, whether with or without the aid and advice of the imperial officers in any of the fields of scientific enquiry to which the Resolution refers The progress made in Civil Veterinary work should, in accordance with the instructions of paragraph 13 of the Resolution marginally
ated quoted, be especially described under the various heads detailed in
57 that Resolution

8 The fifth Resolution refers to positive agricultural experiment and improvement As stated in the orders of 1884 already quoted in the second paragraph, it is not desirable that the annual report should enter into any lengthy discussions on agricultural subjects or describe the working of the farms The separate reports on the farms themselves, which are submitted to the local Government, as well as the notes on any interesting experiment or improvement which the Department is required to communicate to the editor of the *Agricultural Ledger* will supply detailed information to all who may require it The annual report is only intended to indicate the general character of the programme which the

ment and of the staff by which they are managed, it should indicate the system, if any, which is adopted for carrying experiments into estates under Government or private management, and for obtaining the co-operation of native landowners It should then give a brief description of, or reference to, any results of special and material interest which have been obtained on farms or estates during the preceding twelve months It should next explain what

it has appeared, such reference obviating the necessity of giving any special account of it in the annual report Finally, it may include a record of any interesting facts which have been otherwise brought to light during the year in connection with agricultural enquiry and improvement, although in these cases also a reference to the *Agricultural Ledger* ought to prevent the necessity of anything more than a brief allusion to them.

9. The sixth Resolution deals with agricultural education. Under this head should be included a statement by the Director for the information of the local Government how far the educational system of the province is found to meet the requirements necessary for the instruction of boys or students designed for village accountantships, for circle appointments, or for an agricultural calling, and to what extent that system is or should, in his opinion, be supplemented by special departmental arrangements and educational classes

In dealing [illegible] sible, follow tl[illegible] subject and bri[illegible]

10. The seventh Resolution deals with the publication of information, facts, and statistics Under this head the following points should be noticed in the annual report —

(1) The extent to which information has been obtained from the district circle note-books of the occurrence and cause of serious agricultural deterioration This may be illustrated by a record of the number of communications received

(2) The system maintained for ledgering useful facts and information from district and settlement reports, from the reports of the scientific departments or from similar sources of information, and the general progress which has been made, or the difficulties which are found in the ledger work.

(3) The publication, or measures, if any, taken for the preparation of a statistical atlas or of any other special works designed either to illustrate the agricultural or economic conditions of the province, or of any part of it, or to indicate the position and needs of any agricultural or commercial industry.

(4) The number of papers communicated by or through the agency of the Department to the *Agricultural Ledger*. A list of these should be given in an appendix to the Report.

(5) The number of papers received from, or communicated to, other provincial departments.

11. In conclusion, it is left to the discretion of the Director, under such instructions as he may receive from the local Government, to bring forward any matter of interest which has been brought to his notice during the year and which bears upon the work of his department

12 Under the instructions of this Resolution the headings of the chapters of the Director's report will be—

I. Prefatory
II. Land Records Establishments
III. Utilization of land records.
IV. Scientific and national enquiry under imperial control.

V. Scientific and local enquiry under provincial direction.
VI. Agricultural education.
VII. Publication of agricultural information.
VIII. Final.

The Government of Madras
" " Bombay
" " Bengal
" " North Western Provinces and Oudh
" " Punjab
The Chief Commissioner, Central Provinces
" " " Burma
" " " Assam
" " " Ajmere
" " " Coorg
The Resident, Hyderabad
" Inspector General of Forests
" " Civil Veterinary Department
The Agricultural Chemist to the Government of India.
The Reporter on Economic Products to the Government of India

Order—Ordered, that a copy of the foregoing Resolutions be forwarded to the Local Governments and Administrations and officers noted in the margin for information and guidance, and that the Reslou-tions be published in the Supplement to the *Gazette of India* for general information.

Ordered also, that a copy be forwarded to Sir E. Buck, lately Secretary to the Government of India, on special duty.

(True Extract.)

DENZIL IBBETSON,

Secretary to the Government of India.

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